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THE PYELOGRAPHIC AND ROENTGENOLOGIC DIAGNOSIS OF RENAL TUMORS¹

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TUMORS of the kidney, comprising neoplasms and cysts, are of wide histologic variety. The more common newgrowths include hypernephroma, adenoma, fibroma, and primary or secondary carcinoma and sarcoma. Among the rarer neoplasms are lipoma, hemangioma, fibromyoma, rhabdomyoma, and other mixed forms. Cysts of the kidney may be single or multiple, the latter usually being bilateral. Notwithstanding their histologic diversity, clinically important tumors of the kidney are rare.

Efficient diagnosis of renal tumors is by no means simple and direct, but is arrived at by a more or less intricate process of confirmation and exclusion, the final decision usually requiring a correlation of the clinical, roentgenologic, cystoscopic, and laboratory findings. In this process the X-ray findings play an important, often decisive, rôle. Roentgenologic methods of examination consist of simple roentgenography, pneumoradiography, pneumoperitoneal roentgenography, and pyelography.

SIMPLE ROENTGENOLOGIC SIGNS

In cases of renal tumor simple radiography may reveal, (1) symmetrical enlargement of the renal shadow, (2) local projections of its contour, (3) areas of moderately increased density within a renal shadow of normal size and form, (4) par-

tial or complete concealment of the renal shadow by the shadow of the tumor, or (5) localized densities due to calcified areas in the tumor, or to calculi which are sometimes associated with the tumors.

In several cases of hypernephroma, we have noted dense fimbriated streaks of calcification, unlike those observed in any other condition, and this sign may prove of diagnostic value. Obviously, none of the other manifestations mentioned can be pathognomonic of renal tumor. Symmetrical enlargement of the renal shadow may be due to a "large white kidney"; calculi are not necessarily associated with tumor, and, if present, their shadows are likely to be regarded as representing the only lesion; the other abnormal shadows may result from extrarenal tumors. Vague shadows in the renal area, often present under normal conditions, are a possible source of deception. On the other hand, a renal tumor of clinical moment may not be demonstrated by a simple roentgenogram.

When an abdominal tumor is known to exist, examination of the stomach with the opaque meal and of the bowel with the meal or enema will aid in determining its relation or non-relation to the kidney. A tumor of the stomach or intestine will usually manifest diagnostic signs. A gross tumor of the kidney is likely to displace the adjacent segment of the colon, or to thin its opaque

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contents by pressure, but extrarenal tumors may produce identical signs.

Roentgenograms showing metastasis in the chest or osseous system sometimes furnish the first clew to an unsuspected malignant tumor of the kidney, and the frequency of such metastasis from renal embryomas in children should be kept in mind.

On the whole, while the ordinary roentgenologic examination often reveals phenomena compatible with the presence of a renal tumor, they alone are not sufficient to establish a diagnosis, even when associated with a palpable mass in the renal area.

To supply the deficiencies of simple radiography, some examiners have occasionally employed pneumoradiography and pneumoperitoneal roentgenography. By injecting carbon dioxide or oxygen into the perirenal fatty tissues, the shadow of the kidney is made to stand out more clearly. Pneumoperitoneal roentgenography or radioscopy also gives material assistance in depicting the outline of the kidney, especially of its lower two-thirds. Despite the advantages of these supplementary methods, each has some degree of hazard, and neither can be depended on routinely for diagnosis.

PYELOGRAPHIC SIGNS

By showing deformities of the renal pelvis produced by tumors, pyelography easily takes first rank in their roentgenologic demonstration. Here the roentgenologist and urologist come into most intimate association, and their thorough co-operation is requisite for satisfactory results.

Changes in the pelvic shadow resulting from neoplasms and cysts include (1) elongation of one or more calices, or of the true pelvis; (2) shortening of the calices; (3) encroachment on the pelvic lumen causing flattening of the pelvic contour, narrowing of individual calices, obliteration of one or more calices, or obliteration of the true pelvis; (4) broadening of the calices; (5) pyelectasis; (6) displacement of the pelvis, and (7) deformity of the ureteropelvic juncture.

Elongation of one or more calices is perhaps the earliest pyelographic sign of a parenchymal neoplasm. As the tumor extends peripherally, it draws the calix out with it. The elongation is usually accompanied by narrowing of the lumen of the calix, obliteration of its finer terminal divisions, and more or less deformity of the true pelvis. Narrowing of the calix is not always regular, and there may be local dilatations; with incomplete filling, only the dilated portions may appear on the film. The number of calices involved increases with the size of the tumor. When multiple calices are affected, the growth has usually invaded the greater portion of the kidney. Elongation may be extreme, even to 10 or 12 cm., and the narrowed, radiating calices resemble the legs of a spider.

The multiple cysts of a polycystic kidney may also elongate the calices, but, as a rule, the elongation is less pronounced, the calices are more often widened than narrowed, and terminate bluntly rather than in the narrow streaks typical of neoplasm.

By the encroachment of a tumor, the true pelvis is sometimes markedly elongated and narrowed. In such instances all of the renal parenchyma is likely to be involved.

Shortening of the calices is a more common effect of cystic tumors than of neoplasms.

When a tumor invades the pelvic space to any considerable extent, it causes proportionate filling defects in the pyelogram. One or more of the calices may be narrowed or obliterated, the filling defect may be localized to one portion of the true pelvis, or the pelvis may be completely obliterated. If the mass has completely filled the pelvis, no evidence of the injected medium can be found in the renal area, the ureteral shadow ending irregularly at the ureteropelvic junction.

Broadening of one or more calices often occurs in polycystic kidney, and, as before noted, may be associated with some degree of elongation.

Dilatation of the true pelvis, or pyelectasis, may result from its elongation by a

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renal tumor, sloughing of neoplastic tissue, or obstruction of the pelvic outlet by a pelvic tumor. The condition may sometimes be inferred from the discovery of residual urine in the pelvis, or from the introduction of a large quantity of the opaque medium without pain. When the pyelogram shows not only an expansion of the pelvic space, but also deformity by pelvic filling defects or obliteration of the terminal markings of the calices, the pyelectasis is probably due to a tumor. Dilatation without such deformity occurs in hydronephrosis from other causes.

A renal tumor may displace the kidney in any direction, or rotate it markedly. In the pyelogram the pelvic shadow may be displaced upward, downward, laterally or mesially, and the axis of the pelvis may be turned to any angle, but since the kidney may be displaced considerably by its normal excursion or by extrarenal tumors, displacement is not significant unless associated with pelvic deformity.

Tumors sometimes invade not only the pelvis, but also the upper portion of the ureter. As in the pelvis, such involvement may either cause dilatation of the ureter, or fill its lumen so completely as to exclude the opaque medium. The pyelographic evidence will be obvious in either instance. Unless pelvic deformity is also apparent, ureteral dilatation is not diagnostic of tumor, as ureteral obstruction may likewise have other causes.

Occasionally a renal tumor will displace the ureter without otherwise affecting it. More often the displacement is median, and the ureter curves widely inward over the vertebral column.

DIFFERENTIAL DIAGNOSIS

Before attempting to interpret the pyelogram, assurance must be had that the renal pelvis was given every opportunity to fill completely with the opaque medium, so that if anomalies of the shadow exist they are not due merely to defective filling. A pelvis which is only partially filled will pro-

duce a shadow with deformities which may readily be mistaken for those produced by a tumor.

The normal pyelogram and variants.—Not less important than a scrupulous technic is a thorough familiarity with the normal



Fig. 1. Normal pyelogram. Note elongated major calices. The terminal irregularities of the minor calices are well retained.

pyelogram, and especially with its normal variations. An ideally normal picture, however, is rare, and often there are peculiarities which can be misconstrued.

While it has been shown that the embryonic pelvis is bifid, and that this tendency may be carried to maturity, three major calices are commonly visible in the pyelogram. Sometimes only two are visible, in which event the lower usually subdivides into two secondary major calices, so that really three principal divisions are present. However, when only two calices are apparent, it should not be assumed, without additional evidence, that a third calix has been obliterated by a tumor.

One or more calices of a normal kidney, especially the upper calix, may be distinctly elongated. However, this elongation is not accompanied by narrowing of the calix, or deformity of other portions of the pelvis,

such as would almost inevitably be produced by a tumor (Fig. 1).

The normal true pelvis may present any one of a variety of configurations. It may be large or small, short and blocky, or long

On the whole, slight abnormalities in the pyelogram should not be regarded seriously unless strongly supported by clinical facts, and the more trivial the defect, the stronger should be this support. Most tu-



Fig. 2. Pyelogram showing displacement and deformity of the pelvis produced by pressure of a retroperitoneal tumor.

and narrow. But, whatever its general shape or size, it is unmarred by defects, at least of sufficient extent to warrant suspecting a tumor.

Caution is necessary in interpreting the shadows of the minor calices and their terminations; often some of them are superimposed, and thus obscured or apparently deformed. Even when some of the minor calices are not well defined, if others are normal, it may be assumed that the entire pelvis is normal. Blurring of the pelvic shadow by movement should not be misinterpreted as deformity.

Comparison of the kidneys when pyelography of both is feasible, will avert many errors. However, both should not be submitted to this examination at the same time. Ordinarily, the pelvis have similar configurations, but many exceptions occur, and perfect symmetry of the pelvis is not to be expected. Indeed, they may be quite unequal, especially if unequally distended.



Fig. 3. Filling defect in pelvis caused by blood clot, simulating deformity produced by primary pelvic tumor.

mors giving rise to symptoms cause unmistakable deformity in the pyelogram (Fig. 2).

When it is established that the pelvic shadow is definitely abnormal, three additional steps in diagnostic analysis remain: (1) to exclude lesions outside the kidney, (2) to exclude renal disease other than tumor, and (3) to distinguish, so far as possible, between different varieties of tumor.

Extrarenal tumors.—An enlarged spleen, a Riedel's lobe of the liver, retroperitoneal cysts and other tumors in the vicinity of the kidney are sometimes hard to distinguish from true renal tumors. When an extrarenal mass casts a shadow separate from that of the kidney, the ordinary roentgenogram suffices to establish the non-relation of the two. Quite often, however, the shadows are merged. Then the chief roentgenologic distinguishing mark of non-renal tumors is the absence of pelvic deformity in the pyelogram. Occasionally, a tumor outside the kidney will by its pressure deform the renal

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pelvis, and elongate or constrict the calices so that the pyelographic diagnosis would err. Interpretation may also be difficult when a non-renal tumor is associated with an anomalous branching and arrangement

and all the evidence must be carefully weighed (Fig. 3).

Atrophic and cicatricial contraction of the true pelvis following inflammatory disease produces a small irregular shadow of



Fig. 4. Pyelogram of hypernephroma. Typical elongation and tapering of calices.

of the calices. One point of minor value is the fact that displacement of the pelvis by extrarenal tumors is commonly less than that by renal tumors.

Renal lesions other than tumor.—Enlargement of the pelvic cavity by its elongation, or by the sloughing of a neoplasm, has some resemblance in the pyelogram to an open hydronephrosis, or if the pyelectasis is marked and the opaque medium is diffusely distributed, the appearance may suggest an extensive pyonephrosis. However, in parenchymal tumors the calices are likely to be extremely narrowed or obliterated, while in hydronephrosis they are broadened. Pyonephrosis can usually be identified by the clinical and cystoscopic findings. In any case of hydronephrosis with a history of hematuria, the pyelogram should be carefully examined for filling defects indicative of malignant papilloma.

A blood clot producing filling defects in the pelvis may arouse suspicion of a tumor,

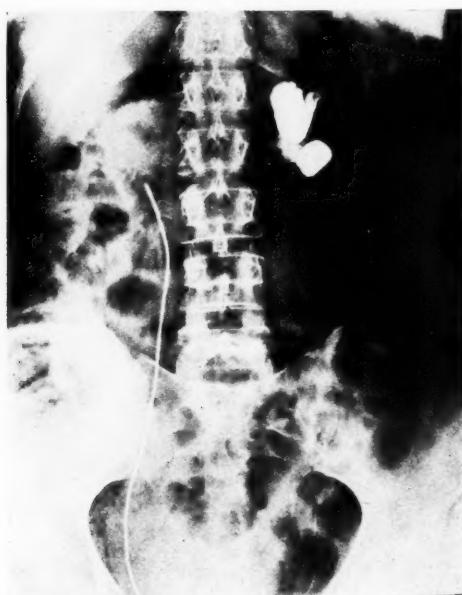


Fig. 5. Pyelogram of epithelioma of the renal pelvis. The pelvis is small and irregular, while the major calices are dilated from obstruction.

the pelvis which might be regarded as evidence of a pelvic neoplasm. In such cases the clinical and cystoscopic findings are requisite for distinction.

Calculi in the pelvis rarely escape detection in the primary roentgenogram but occasionally may produce puzzling filling defects in the pyelogram. It is noteworthy that such stones often retain enough of the opaque medium to cast a recognizable shadow in a second roentgenogram, especially when the silver salts are used.

Complete obstruction of the upper ureter by a tumor so that none of the injected medium can enter the pelvis, requires distinction from that due to a closed hydronephrosis or pyonephrosis. Here the outline of the ureter below may have some dif-

ferential value. Inflammatory conditions with ureteritis cause ureteral dilatation, while an obstructive neoplasm is likely to give rise to a narrowed ureter through atrophy from disuse.



Fig. 6. Odd type of deformity due to tumor in which abbreviation and tapering of the calix are more conspicuous than elongation. The pelvis is extended and narrow.

DISTINCTION AMONG VARIETIES OF TUMOR

While final decision as to the nature of a renal tumor can, of course, be given only by the pathologist after microscopic examination, it is desirable to carry the pre-operative diagnosis as far as it can reasonably be carried. To forecast the probable character of a tumor entails a close study of all the clinical, cystoscopic and roentgenologic evidence, and although the conclusions drawn cannot be absolute, they may be of practical value.

Hypernephroma.—Since hypernephroma is by far the most common of clinically important renal neoplasms, the possibility of its presence should be determined first of all. The pyelogram typical of this condition shows deformity of the calices rather than of the true pelvis. As hypernephroma

often arises in the upper pole, the upper calix is likely to be most affected. The involved calices are elongated and narrowed, although sometimes local dilatations alternate with narrowed portions (Fig. 4).



Fig. 7. Oval outline of pelvis and obliteration of calices which occurs as a result of compression from cortical cysts.

Sometimes the primary roentgenogram reveals fine, linear, calcified streaks. Roentgenograms of the chest or bones may show metastasis.

In hypernephroma the classic clinical triad of pain, palpable tumor, and hematuria is usually emphatic. Pain is severe, a tumor can be palpated in most instances, and hematuria is pronounced, though infrequent. Mature adults are attacked more often than young persons. The so-called hypernephroma of children is really an adenocarcinoma (Kaufmann).

Carcinoma.—In the pyelogram of carcinoma the pelvic space is likely to be irregularly enlarged by sloughing, which occurs early. Metastasis is common. The clinical triad is not marked; in most cases the tumor cannot be discovered by palpation, the majority of patients have little or no pain, and bleeding is seldom profuse. Cachexia is pronounced.

Adenocarcinoma produces greater deformity of the pelvis than does hypernephroma. With a short history and marked deformity of the pelvis, the possibility of adenocarcinoma should always be considered.

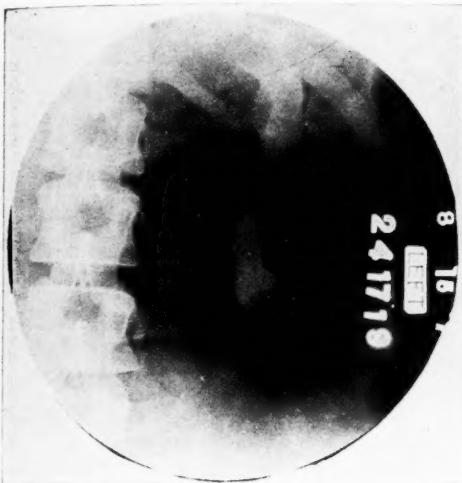


Fig. 8. Type of deformity more commonly observed in polycystic kidney which is characterized by elongation and broadening of calices in contradistinction to narrowing observed with neoplasms.

Papillary epithelioma, though rare, is the most common tumor originating in the pelvis itself, but benign papilloma, inflammatory granuloma, or angioma may occur. Extensive papillomatous growths may largely obliterate the pelvic lumen, making the pelvic shadow small and irregular (Figs. 5 and 6). More frequently the pelvis is dilated as a result of ureteropelvic obstruction, and the enlarged pelvic shadow may also show marginal filling defects. Seldom are the calices elongated or obliterated as in parenchymal tumors. Transplants at the cystic ostium of the ureter, or elsewhere in the bladder, discoverable by cystoscopy, aid in identifying malignant papillomas. Calculi are often associated with them.

Polycystic kidney.—Abnormalities of the pyelogram are less constant with polycystic kidneys than with renal neoplasms. When present, the deformities of the pelvis are often notably different from those pro-

duced by newgrowths. In contrast to the elongation and narrowing of the calices common in neoplasms, elongation is infrequent in polycystic kidneys, and likely to be associated with widening of the calix. When a calix is moderately compressed

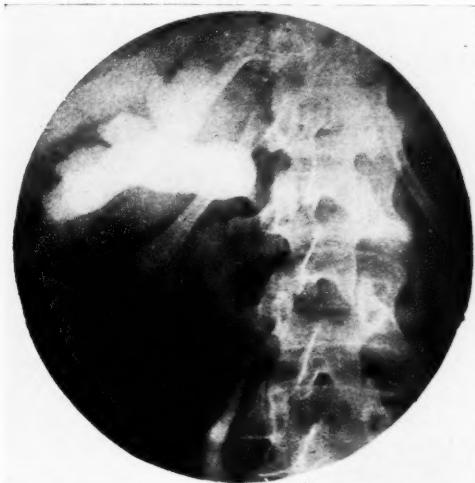


Fig. 9. Solitary cyst. Pelvis horizontal and dilated; clubbing of the calices, and median displacement of the ureter.

by a cyst, it tends to assume a circular or semicircular outline which is highly suggestive. If compression is extreme, one or more of the calices may be obliterated. With complete blotting out of the calices, the pelvis takes on an oval or cylindrical shape which is characteristic. The pelvis may be displaced to unusual positions, or its axis may be turned to the horizontal, or even downward. Changes due to secondary infection of a polycystic kidney generally produce large, irregular, cortical areas in the pyelogram, and the pelvic outline may be confounded with that of pyonephrosis (Figs. 7 and 8).

Solitary cyst.—A large solitary cyst, or a smaller one near the pelvis may cause (1) shortening of the adjacent calices, (2) flattening of the nearest portion of the true pelvis, and (3) changes in the axis of the kidney by the weight of a cyst seated at

either pole. With marked shortening of the calices, the pelvic shadow becomes cylindrical like that in polycystic kidney. Occasionally the deformity resembles that produced by a neoplasm. A normal pyelogram will not wholly exclude the presence of a cyst, for it may be so situated as not to deform the pelvis (Fig. 9).

Benign neoplasms and metastasis from malignant growths.—These have no marks

of distinction from other renal tumors, but they are so rare that they should be placed last in the list of possibilities.

In conclusion, it may be pointed out that while experience has proved the great value of pyelography in the diagnosis and distinction of renal tumors, it has certain well-known contra-indications, and should not be employed when the diagnosis is obvious without it.

"Madelung's wrist."—In 1878 Madelung described spontaneous dislocation of the hand forward, a deformity which has since borne his name. In 1885 Duplay described a similar deformity but in which there was an anterior curvature of the radius in addition to the subluxation. In the literature these are rather indiscriminately called "Madelung's wrist."

The onset of the condition usually occurs during adolescence (12 to 14), the onset being without pain, and may or may not be preceded by trauma. Four classes occur: 1. Those with simple hypertrophy of the distal end of radius and ulna (it is difficult to see how these can be classed as Madelung's deformities, yet about one-third of the reported cases are in this class); 2. Simple subluxation with relaxed ligaments; 3. Subluxation with changes in the articular surface of the radius and dislocation of the head of ulna, which is difficult of reduction; 4. Curvature of the radius associated with dislocation of the head of ulna and changes in carpal bones, which is impossible of reduction.

W. W. WATKINS, M.D.

Radius Curvus (Madelung's Wrist). B. H. Moore. *Jour. Bone and Joint Surg.*, July, 1924, p. 568.

Hematuria.—Lesions primary in the upper urinary tract contribute more than 50 per cent of hematurias. The majority of renal hematurias are microscopic. At least 50 per cent of massive hematurias are caused by tumors of the

bladder. The majority of renal tumors are associated with hematuria, and in at least 75 per cent of cases they give rise to massive bleeding. This, in the presence of stone, inflammation or tuberculosis, should suggest the possibility of an associated neoplasm. Renal calculi situated in the parenchyma are prone to give rise to more bleeding than are smooth stones in the true pelvis. Hematuria is a symptom that should be looked on as an indication for a complete urologic study, except in cases in which the underlying cause is obviously extra-urinary and the lesion non-surgical.

W. W. WASSON, M.D.
Renal Hematuria. Leon Herman. *Jour. A. M. A.*, Oct. 25, 1924, p. 1315.

Tongue lesions.—Primary tuberculosis of the tongue seldom occurs. Secondary tuberculosis of the tongue is more common than statistics would lead us to believe. The writers found fourteen (1 per cent) cases in a total of 1,444 tuberculous patients. Biopsies of questionable tuberculous lesions of the tongue should not be taken. The entire lesion should be removed, or none at all. The best local treatment in their hands has been the surgical removal by a V-shaped incision of the solitary tuberculous lesion of the tongue.

W. W. WASSON, M.D.
Tuberculosis of the Tongue. Howard Morrow and Hiram E. Miller. *Jour. A. M. A.*, Nov. 8, 1924, p. 1483.

THYROID DISEASE¹

By EDWARD L. JENKINSON, M.D., Assistant Professor of Roentgenology, Northwestern University College of Medicine, CHICAGO

THE object of this conference on thyroid disease is to ascertain the best method or methods by which the disease may be treated. What we want are the opinions of the various men in their selected fields of therapy.

There are, no doubt, many surgeons who believe the only method by which a hyperthyroidism can be cured is through surgical interference. There are also many internists and radiologists who believe their methods of treatment offer the patient the only chance for recovery. There are cases of hyperthyroidism which respond very well to surgery. There are also cases which respond to rest and medical treatment, and I am sure there are many cases which respond to radiation.

In treating a large number of thyroids either by surgery, rest or radiation, one is impressed by certain cases that fail to respond to any method of treatment. There are cases which seem to do poorly, regardless of the method of treatment pursued.

It is useless for the surgeon, the internist or the radiologist to say his method of treatment is the only satisfactory one. It is true, in selected cases, good results can be obtained with almost any type of therapy.

Being a radiologist, I shall not try to prove that this is the only method of treating a hyperthyroidism. I do not believe radiation will cure all cases of hyperthyroidism. I do feel, however, that a large majority can be helped, and in many cases a cure obtained. Not all types will respond to radiation. The cystic and colloid goiters do very poorly when treated by radiation. The simple adenoma with no toxic manifestations should not be subjected to radiation. In many localities the compensatory hypertrophy of the gland is endemic. This is a physiological process and should not be interfered with. The presence of a rapid

pulse or even of a tremor in such cases is not conclusive evidence of an exophthalmic goiter or a hyperthyroidism. Large substernal thyroids causing pressure symptoms are definitely surgical.

The thyroid apparatus is rather complex, consisting of the thyroid gland and a variable number of parathyroid glandules. There may also be an accessory thyroid gland located between the base of the tongue and the aorta. According to Swale Vincent, the pars intermedia of the pituitary is closely related to the thyroid apparatus and may act as a substitute after the removal of the thyroid gland or in case of atrophy. The thyroid gland is closely associated with other hormone-producing organs, such as the generative organs, liver, pancreas, suprarenal capsule, pituitary and thymus. The thyroid consists of two pear-shaped lateral lobes, reddish brown in color, joined together by an isthmus or median lobe. The lateral lobes are located on either side and in front of the larynx, covering the third and fourth rings of the trachea. The upper poles of the lateral lobes are conical, while the lower are thick and rounded. The posterior edge of the left lobe extends behind the esophagus. The isthmus or median lobe is absent in 15 to 20 per cent of cases. The gland varies in size, depending on age, sex, locality of residence and state of nutrition. The gland is relatively larger in infants than in adults, representing about one-eight hundredth of the body weight in infants and one-eighteen hundredth in adults. The average weight of the gland is from thirty-six to fifty grams. The gland of the female is about 33½ per cent heavier than that of the male. The parathyroid glandules are variable in number and position; in 80 per cent of cases there are four, two on either side of the median line. The upper

¹ Read before the Radiological Society of North America at Kansas City, December, 1924.

pair are located in the gland substance posteriorly, while the lower pair are closely adherent to the posterior and external aspect of the thyroid. The thyroid gland is exceedingly vascular. About five times more blood is received by the thyroid than by the kidney, this blood supply being received through the superior and inferior thyroid arteries.

The thyroid has two well-defined phases of secretory activity, namely, the colloid, or resting, and the phase of activity. In the resting stage, acini are distended with a granular or perfectly homogeneous colloid. When a gland becomes active, the vessels enlarge and the colloid becomes vacuolated and absorbed, and there are general changes in the epithelium of the gland. The fresh secretion is markedly fluid. By adding iodine to the general diet, the gland becomes very active, following which activity the process finally subsides and the gland returns to a colloid or resting stage.

The colloid is the reserve of iodine. The thyroid cells liberate the specific hormone for daily use from substances supplied by blood and do not call on the reserve. During certain stages of life, the reserve is called on, such as during puberty, menstruation, pregnancy or lactation, or in a change to high altitude. The invasion of the body by many micro-organisms also calls for an excess of this specific hormone.

The function of the thyroid apparatus may be divided under four heads:

1. To govern the growth of all cells and to sustain their functional activity.
2. To control the calcium metabolism.
3. Katabolic stimulation, facilitating the breaking down of exhausted cells and governing the elimination of waste products.
4. Protective, defending the body not only against the toxic products of its own metabolism, but against invasion by disease producing micro-organisms and injury by their products.

Quoting McCarrison: "Metabolic and anti-toxic functions are exercised by discharging into the lymph stream and blood a

secretion containing its active principle or hormone. It regulates the oxygen intake and the carbon dioxide output, maintains constituents of the blood and salts at a proper level. It also regulates the body temperature to a certain degree. Through its function the arterial tone is influenced and to a certain extent the blood pressure regulated." He says further: "The thyroid is to the human body what the draught is to the fire, nay, more, its iodine by its chemical interaction with certain unknown constituents of the cells is the match which kindles it."

The thyroid gland plays a very important part in the general development of the sex apparatus, the osseous system, the nervous system and also the mentality. It seems to act in close co-operation with the pituitary, thymus, suprarenals and pancreas. It inhibits the action of the pancreas, which is hyperactive in subthyroid conditions. The storage of glycogen and its discharge from the liver is also regulated to a certain extent through the thyroid. Through its action with the gonads, thymus, pituitary and other endocrine organs, it influences calcium metabolism.

Carrel has demonstrated conclusively the action thyroid plays in influencing growth. The brain and other tissues, cultivated *in vitro*, grow several times as fast in the presence of thyroid substance as in its absence. It also plays a very important part in differentiation in the development of vertebrate organisms. By feeding a tadpole thyroid it can be brought to the point of metamorphosis in eighteen days, which normally requires ten to twelve weeks.

Of great importance is the action of the thyroid during pregnancy. The future capacity of the child's thyroid apparatus depends a great deal on the mother's thyroidal resources. The infant's thyroid contains very little iodine. The maternal milk, therefore, furnishes what iodine is necessary. It is very important that a mother try to nurse the child, as cow's milk contains iodine in a very limited amount. During lactation the mother's thyroid gland is

hyperactive. Later on, as the child begins to eat raw materials, the thyroid begins to act, and iodine is secreted.

As a woman grows older and reaches the menopause, the thyroid action becomes depressed. Hyperthyroidism is very apt to appear in elderly women, especially those who have been subthyroidic during their earlier life. The provocatives of abnormal thyroid action are as follows:

1. Defective or improper food supply.
2. Residence in unsanitary surroundings.
3. Bacterial and other toxins.
4. Infectious diseases.
5. Constipation, intestinal stasis and intestinal toxemia.
6. Fright, grief, worry and mental distress.

7. Hereditary factors.

X-ray therapy of the exophthalmic goiter is no longer in the experimental stage. Its usefulness has been accepted by the majority of the medical profession. For a great many years internists have recognized its merits and have used it in selected cases. During the past five years, surgeons have used it as an adjunct or as a pre-operative measure. Many surgeons claim, however, that the pre-operative use of X-ray makes the removal of the gland more difficult. It was formerly claimed that, following its use, the gland became adherent and a large amount of hemorrhage was encountered. We believe, however, that this objection to rays by the earlier surgeons had very little foundation. A number of surgeons have been interviewed regarding the difficulty of operation following the extensive radiation of the thyroid gland, and in most instances they claimed that very little difficulty was encountered. The amount of connective tissue is not unusual and is often encountered following an ordinary thyroiditis.

The question of dosage in the treatment of thyroid is of utmost importance. A fixed technic cannot be established; each case must be treated as an entity, and the technic made to fit the patient, rather than the patient made to fit the technic. X-ray, like

other therapeutic agents, must not be a fixed quantity from which no deviations shall be made. In the treatment of thyroids, as in the treatment of other diseases, experience and judgment play an important part. These patients, as a rule, are nervous and irritable, and during treatment should be made as comfortable as possible; if they are allowed to become unusually nervous and irritable, a definite setback is the result. After a careful physical examination, paying special attention to the heart and nervous system, the size of the dose is estimated. If the patient is markedly toxic and shows a high metabolic rate, the dose must be small; if a large dose of X-ray is given, it may cause a sudden rise in the metabolic rate and lead to a fatal termination.

In dealing with these various toxic cases, it is well to distribute the series over a period of a week to ten days, trying to eliminate the possibility of nausea and vomiting and general malaise. For a number of years we thought it advisable to have all patients hospitalized; this we now believe to be unnecessary, as the very nervous patients seem to do better when at home with their families.

Following the X-ray therapy, there is usually an increase in the size of the gland, accompanied by swelling of the salivary glands, which usually subsides inside of twenty-four hours. It is well to inform the patient before treatment that the gland will become larger following radiation, but that nothing serious will happen, and that in a short while the swelling will subside.

For the past three years the metabolic determination has been made on all patients prior to X-ray treatments, and the amount of treatment depends a good deal on the metabolic determination. Before a second series of treatments is administered, the patient is instructed to return to her physician for a physical examination and a basal metabolism test. If the metabolic rate is still high, the treatment is continued. We have looked upon a basal metabolic rate of below twenty plus, as practically normal,

and only in very few instances have we given radiation. In such cases as have been radiated, the clinical manifestations were such that we thought perhaps a mistake had been made in the determination. As a rule, we ask the physician to have the patient return at a later date for a recheck of the metabolic rate.

The clinical manifestations usually coincide with the basal metabolic rate, though there are times when a frank hyperthyroidism will show a relatively low basal metabolic rate. At such times, the clinical manifestations will usually show a remission. If at a later date there is an exacerbation of symptoms, the metabolic rate will also show an increase. There are a great many cases referred to the laboratory for treatment which show some of the symptoms of a toxic thyroid. These patients are always subjected to a metabolic test before deciding on the type of treatment to be followed. Many cases showing symptoms similar to those of hyperthyroidism are suffering from pathology outside the gland. Is it not possible that changes in the pituitary, pancreas or sex apparatus may cause a temporary disturbance of thyroid activity?

For a number of years a basal metabolism test was looked upon by many surgeons with a good deal of uncertainty. They discounted its value and operated on patients, claiming a basal metabolism gave them no important information regarding the severity of the disease. From past experience, we feel the basal metabolic determination is of the utmost importance in the successful treatment of thyroid toxicosis. Basing our opinion on four hundred cases, we do not believe an exophthalmic goiter or case of hyperthyroidism is ever encountered with the basal metabolism constantly normal or below.

During the treatment of these four hundred cases of goiter, we have yet to see not only a burn, but even a faint skin reaction. It is not only unnecessary, but contra-indicated, to obtain, even after many treatments, a tanning of the skin. In properly selected

cases, there should be a decided improvement after three series, at the most. In all such cases, not more than one-fourth of the erythema dose should be given at any one time. The competent roentgenologist is aware that the skin of a hyperthyroid case is about 30 per cent more sensitive than the skin of a normal individual.

During the past two months we have treated five post-operative goiters. The metabolic rate ranged from 40 to 100.8 plus, the symptoms in all cases coinciding with the metabolic rate. One patient, in particular, claimed that prior to operation the metabolism had never been above 60 plus. Following operation, she had an increase to 100.8 plus.

In discussing the shortcomings of the surgeons, it might be well to mention two fatalities which occurred in our series of four hundred cases. The cause of death was not determined in either case, as autopsies were not obtained. The X-ray dosage was very small and distributed over a period of ten days for one series. Both patients had been previously treated and showed nothing unusual during the period. These two fatalities are mentioned to warn the physician, although we do not believe death was due in any way to X-ray. It is well to remember, when talking to the patient, not to be too optimistic, as fatalities do occur in many cases of hyperthyroidism, due entirely to the disease and not to the type of treatment administered. The results in a great majority of cases have been uniformly good. We feel that about 80 per cent of hyperthyroids will respond to X-ray therapy and a cure be obtained. By a cure we mean freedom from recurrence for not one or two years, but over a period of five to eight years. We have knowledge at present of many cases treated in 1916, who have had no further treatment and have remained perfectly well. From time to time, metabolic determinations have been made and have been found to be normal.

In a certain percentage of cases it is necessary, from time to time, to give occasional treatments. These patients experi-

In all of the cases of exophthalmic goiter, in our experience, there has been very little difficulty and are able to continue their daily duties. In the failures, which number about 20 per cent, it has been our experience that very little benefit is received, regardless of what type of therapy is instituted. If radiation fails to produce a cure,—speaking now of the exophthalmic type,—surgery in most cases is also a failure. The treatment of exophthalmic goiters in males, in our experience, has been rather unsatisfactory. Fortunately, the number of male patients has been very limited.

SUMMARY

1. About 80 per cent of exophthalmic goiters will respond to X-ray therapy.
2. The metabolic determination is the most important guide and is indispensable

in the successful treatment of exophthalmic goiters.

3. It is impossible to treat thyroid disease in a routine manner. Each case should be treated as a separate and distinct entity.

4. Patients should be followed by occasional metabolic determination for a number of years following treatment. It is also important that these patients keep in close contact with their physicians.

5. We believe a large percentage of cures reported by the surgeons are due to the fact that the surgeons lose contact with their patients. It is true that when the patient leaves the hospital, following the operation, she is undoubtedly improved, but later on the symptoms return, the gland becomes activated, and the patient returns to the family physician with her future complaints.

Gastro-duodenal ulceration.—It is the author's opinion that the number of positive diagnoses of gastric ulcer which can be made by radiographic examination increases much with the skill and experience of the investigator. There are some cases, however, in which an ulcer may be present but is not demonstrable roentgenologically. On the basis of X-ray examination, before and after medical treatment, it may be conceded that a few ulcers with demonstrable cratera will disappear. The chance of this happening, however, is not a great one.

In some clinics a correct X-ray diagnosis is claimed in over 90 per cent of the cases. In England, however, such a high degree of diagnostic efficiency is not obtainable for the present, at least, in hospital practice, because repeated examinations and serial methods are precluded by pecuniary reasons or want of time. Often, though, the actual ulcer cannot be seen because perhaps the crater is plugged with food or mucus, and a positive diagnosis must be

made on indirect X-ray evidence and particularly on the basis of a characteristic history.

In discussing duodenal ulcers, the writer is convinced that not infrequently an ulcer situated on the posterior wall of the duodenum can very easily be overlooked even at operation. On several occasions he has first become aware of the presence of a second duodenal ulcer behind, when a resection operation had been begun and the viscus was in the process of separation. He has also seen an ulcer, which could not be detected by the pathologist until the intestine had been actually opened. The writer suggests that the surgeon should examine his patients in collaboration with the radiographer. In this way he obtains a better grasp of the value of radiographic diagnosis in gastric and duodenal ulceration.

SOLOMON FINEMAN, M.D.

Surgical Treatment of Gastro-duodenal Ulceration. Charles A. Pannett. *Brit. Med. Jour.*, March 14, 1925, p. 489.

THE SURGICAL ASPECT OF THYROTOXICOSIS¹

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THE subject of thyrotoxicosis is well fitted to be the basis of a conference, since three broad methods of treatment, medical, surgical and radiological, may justly claim under proper conditions to influence the course of the disease. It is taking a narrow view of the situation to consider these forms of treatment as being in competition with one another. What may be accomplished by each method has its limitations. We are interested in the good of the individual patient, and not in advocating any particular type of treatment. The patient's best interests may demand the use of two, or even all three forms of treatment, which should be looked upon by us as methods supplementing each other, rather than as competitive.

Before proceeding with a discussion of these forms of treatment, the term "thyrotoxicosis" needs further definition. "Thyrotoxicosis" I take to be a convenient designation used to describe forms of thyroid disease showing constitutional disturbance, apparently due to a secretion from the thyroid gland increased in amount, abnormal in character, or both. It seems certain that two types of cases are ordinarily included under the term "thyrotoxicosis." One is exophthalmic goiter; the other is adenomatous goiter with hyperthyroidism. Distinction between these two types of disease I believe important, since their response to treatment is not the same.

The diagnosis between these types of thyroid disease has been clearly pointed out by Plummer (1), although in certain cases the distinction may be difficult. Ordinarily the history of a goiter long preceding the toxic symptoms, the nodular character of the thyroid enlargement, and the absence of exophthalmos, serve to distinguish the adenomatous type. In discussing the question of treatment, my remarks apply to exophthalmic goiter, except where ade-

matous goiter with hyperthyroidism is specially mentioned.

During the past five years, as a member of the Thyroid Committee of the Massachusetts General Hospital, I have had an opportunity to follow the cases of thyroid disease coming to the clinic, whatever the form of treatment. The total number is not large, but many of the patients have been under sufficiently continued observation to enable us to give an estimate of the final result. During this period my ideas as to the relative value of different forms of treatment have become increasingly definite.

The use of the roentgen ray in this clinic received a distinct impetus from early metabolic studies in exophthalmic goiter. These appeared to show approximately equally good results from operation and from radiation. But the surgical results considered were those following removal of one lobe of the thyroid gland only, an operation which is now recognized as inadequate. It produces a distinct clinical improvement, but is rarely curative except after the lapse of a considerable period of time. Under these conditions, since there was a considerable operative mortality, there was naturally a swing toward roentgen-ray treatment. Later, when operation, commonly described as subtotal thyroidectomy, or removal of the whole thyroid except enough to maintain function, became the accepted surgical treatment, studies of metabolism showed a marked difference in our clinic between the results of radiation and those of surgery.

In a series of cases of exophthalmic goiter treated by roentgen ray, reported by Means and Holmes (2), about one-third of the cases were apparently cured, one-third improved, and one-third unimproved by roentgen-ray treatment. While the more recent results of roentgen-ray treatment have not been compiled, my impression is that they remain approximately the same. At

¹ Read before the Radiological Society of North America, at Kansas City, December, 1924.

any rate, a very considerable proportion of cases are essentially uninfluenced by radiation. On the other hand, judged on the same basis as the cases treated by radiation, 70 per cent of cases treated by subtotal thyroidectomy are apparently cured, that is, are without clinical evidence of persistent thyroid toxemia, and have a metabolic rate within normal limits, although in both groups symptoms due to permanent organic damage, particularly cardiac, may persist.

In general, the metabolic rate parallels the clinical course of the disease with sufficient closeness to be used as a measure of the effect of treatment. If this is taken as a guide, the surgical cases at the end of a year show an average metabolic rate of plus 3, the roentgen-ray cases, plus 20 per cent. I take it as definitely shown, at least to the satisfaction of our Thyroid Committee, that subtotal thyroidectomy is in general a more rapid and effective form of treatment in exophthalmic goiter than is radiation with roentgen ray. The case for radiation must be put on other grounds.

At the same time, subtotal thyroidectomy does not bring about a reduction of the metabolic rate to within normal limits in all cases. The failures, aside from the cases permanently damaged as a result of the disease, are chiefly of two types. In the larger, the amount of thyroid tissue removed at operation is insufficient to restore a normal metabolic rate. Instead of a drop to within normal limits, occurring within a few weeks of operation, the metabolism stays elevated, and is likely to remain so indefinitely, unless reduced by further operation or other treatment. That this type of failure should occur is not surprising, since the amount of thyroid tissue to be removed is an estimate on the part of the operator, based in part on the apparent severity of the disease, and in part on the size of the thyroid. In occasional rare cases, there may be an actual hypertrophy of the remaining thyroid tissue, after a period of months or years, with recrudescence of symptoms. These cases need fur-

ther treatment. There is also a group of cases, common both to surgery and irradiation, in which symptoms of the disease persist in spite of reduction in metabolism; these cases may be benefited by the use of iodine. Surgical myxedema has not occurred in our cases.

While it is sometimes disputed as to whether the improvement following roentgen ray is due to the treatment, I am convinced that in the majority of cases this is a fact. The improvement follows too definitely and often too sharply the use of irradiation to be due to chance, particularly since in most of our cases no other factor influencing the course of the disease is introduced. Although Hyman and Kessel (3) show average metabolic curves in cases untreated except by rest and possibly iodine, very similar to the average curves of Means and Holmes (2), it is not clear to me that the degree of relief in the cases most benefited equalled that of a similar group in the roentgen-ray series.

The most important argument for roentgen-ray treatment is that of safety. Here we must distinguish between the immediate safety and the ultimate safety of the patient. While irradiation is without immediate risk, there is a mortality which is hard to visualize, that from progress of the disease in unrelieved or partly relieved cases. Surgery carries a risk of death, or recurrent laryngeal paralysis, and of tetany. Such bad results are infrequent and will tend to be proportionate to the experience of a surgical clinic.

In my own very small series of 102 patients with thyrotoxicosis, operated on since the organization of the Thyroid Clinic, of whom 86 were cases of exophthalmic goiter, there have been three deaths in the hospital, one case of bilateral adductor paralysis, and one case of tetany, both completely recovered from, but there has been no mortality in the last 90 cases. There is reason to suppose that since the introduction of the use of iodine as a preliminary to operation, the surgery of exophthalmic goiter is safer than it has ever been. The price to pay for

the greater certainty of surgical results is not excessive.

While the advantages in roentgen-ray treatment, absence of scar, freedom from the apprehension and discomfort of operation, and the lack of necessity for hospitalization, are apt to carry weight with patients, the situation is too serious to give these much consideration. It is better to have cicatricial tissue in the neck than in the myocardium.

Until recently, complete surgical treatment in many cases could be safely carried out only by means of a graded series of operations. This required time, possibly as much as four months, repeated hospital entries, and constituted for most patients a trying ordeal. Roentgen ray, which might be curative after five exposures in an equal period of time, had a definite claim for consideration. Under these conditions my own conclusions (4) were that while subtotal thyroidectomy was the most effective form of treatment, the use of roentgen ray was justifiable in selected cases under careful control during a period of four months. If cure was not promised at the end of that time, operation should be undertaken. Cases showing evidence of actual or threatened organic damage, particularly cardiac, should be treated by surgery, and not by radiation.

Recently Plummer (5) has suggested the use of iodine in exophthalmic goiter. This drug exerts a profound, though temporary, effect on the course of the disease. It produces a variable, but usually marked, fall in the metabolic rate, accompanied by a distinct clinical improvement. Its effect is only temporary, reaching ordinarily a maximum in from ten to fourteen days. If the drug is continued, the metabolic rate gradually rises to its previous level, and the symptoms recrudesce. If the iodine is withdrawn, the metabolic rate rises rapidly. After the iodine effect has been once obtained, it is more difficult to secure it a second time. The remission in the course of the disease, produced by iodine, creates a favorable opportunity for operation. Since the action of the

drug is temporary, its effect should not be wasted, and it should be given as part of a definite operative program. Iodine not only causes a definite temporary improvement, but it reduces the post-operative reaction, which has been one of the chief dangers of surgery in this disease. The lessening of the post-operative restlessness, excitability, and nervous tension is striking in the patients who have received iodine. It is, therefore, in most cases an effective substitute for the graded operations previously necessary in treating this disease surgically, although even with its use, cases of exophthalmic goiter are far from normal operative risks, and the well-tried principle of repeated partial operations should be abandoned with caution.

Certain things are important to note in the use of iodine. In the first place it is effective only in exophthalmic goiter. If given to cases of non-toxic adenomatous goiter, it may cause them to become toxic. Cases of adenomatous goiter with toxicity may be made worse by it. Diagnosis, therefore, should be accurate. Its use should be limited to cases of exophthalmic goiter, and here the action is not curative. Even in these cases it should not be used as a part of medical treatment unless operation is contemplated, although it may be useful in helping to clear up residual symptoms after operation.

Since the majority of cases of exophthalmic goiter may now be operated on safely in one stage following the use of iodine, my opinion of the place of roentgen-ray treatment has been definitely modified. It may be given more clearly if the cases of goiters with toxicity are separated into groups.

In the first place, I assume that it will be conceded that cases of non-toxic goiter, with normal metabolism, needing treatment for deformity, for pressure, for potential malignancy, or potential hyperthyroidism should be treated by surgery and not by irradiation. The exception in this group lies in the malignant cases, in which irradiation may be valuable.

The first group of cases I wish to consider are the adenomatous goiters with thyrotoxicosis. While certain of these cases may be influenced by the roentgen ray, I believe the treatment should be surgical for the following reasons: The onset of toxicity is insidious, and at the time it is recognized the heart is likely to be involved. The source of the toxemia, instead of being secondary to an unknown cause, as in exophthalmic goiter, appears to be the adenomatous tissue in the thyroid; therefore removal of this abnormal tissue is logical, particularly since it may be harmful in other ways. This idea is borne out by the late results of operation, which are somewhat better than in exophthalmic goiter.

A second group consists of cases of exophthalmic goiter with severe toxemia and progressive loss of weight, possibly leading to vomiting and the development of an acute thyroid crisis, a condition likely to prove fatal. Under these conditions, the time necessary to obtain the cumulative effects of irradiation is out of the question. The indication seems to me clearly to be to secure a remission at once by the use of iodine, and take advantage of the temporary improvement to carry out a partial removal of the thyroid gland.

A third group comprises the cases of exophthalmic goiter with visceral damage; the cases with auricular fibrillation, myocarditis, cardiac decompensation, or other organic changes. The time required for relief by the roentgen ray is harmful to these cases, even should relief be obtained, and particularly harmful to a considerable proportion of cases that may undergo four months' treatment without relief, or with only partial benefit, a period during which the organic disease progresses or may become fatal. While these cases include the poorest surgical risks, prompt and complete relief of toxemia is demanded, and this can almost certainly be obtained by surgery after the use of iodine. I believe that the treatment of these cases should be surgical.

Finally, there remain the cases in which the exophthalmic goiter is relatively well

tolerated. These comprise the early moderately acute cases, particularly in young people, and certain mild chronic cases. In them the time factor is not so important. When these cases are properly selected, a difficult matter in itself, the use of roentgen ray is open to criticism chiefly from the point of view of its effectiveness. Certain of these cases it will cure; in others it will completely fail. Since the latter cases are usually willing to undergo operation, the loss is perhaps not great. Other cases, perhaps a third, are definitely benefited, but not cured. These cases constitute a real objection to the roentgen ray. They recognize their benefit, and are therefore unwilling to undergo surgery. These cases of chronic persisting toxemia I believe constitute a real objection to the use of the roentgen ray.

The combination of roentgen ray with partial operation, such as ligation of the thyroid vessels, has not proved more satisfactory in our hands than either form of treatment alone. Nor has the use of iodine coincidentally increased the effectiveness of roentgen-ray treatment. It produces a drop in metabolism which obscures the effect of irradiation, but does not increase its ultimate effect. In fact, our impression is that roentgen ray is less effective in cases in which iodine is given.

I have so far said little in regard to medical treatment. Its value in connection with other methods cannot be over-estimated. Cases of exophthalmic goiter should not be treated except in conjunction with an internist. To him should be left the general supervision of the patient. A complete study of the patient, with an accurate diagnosis of the condition, is of the first importance before beginning any treatment. In this way such conditions as incipient tuberculosis, neuro-circulatory asthenia, and simple goiters in unstable women, will be excluded. The type of hyperthyroidism should be accurately determined. Finally, complicating factors, such as cardiac impairment, hypertension, nephritis and diabetes, should be recognized. The treatment of these complications, the use of digitalis,

and the preliminary course of iodine should be under his direction. This supervision should follow through during active treatment of the hyperthyroidism, and continue after apparent cure.

The treatment of hyperthyroidism by medical measures alone seems to me to have even less to be said in its favor. We are familiar with no form of treatment which exerts a sufficiently positive influence on the course of the disease. The effect of iodine, while striking and valuable, is as yet only temporary. Not all cases of thyrotoxicosis progress to organic damage, chronic invalidism, and death. There is a distinct tendency in certain cases of exophthalmic goiter to return to normal in time. Unfortunately these cases cannot be picked out in advance. It is true that prolonged rest, proper hygienic conditions, and relief of mental stress may lead to improvement and favor this return to normal, but it will be at the expense of many patients damaged by the disease. Nor is the return to economic usefulness, a standard suggested by Hyman and Kessel, a satisfactory criterion of relief. Patients may maintain their economic status with a persistent mild hyperthyroidism which leads to permanent ill effect. Adequate treatment should restore the metabolic rate rapidly to within normal limits, and this, as yet, medical treatment cannot do. Nevertheless I believe that the ultimate solution of the exophthalmic goiter problem will be medical, and not through surgery or irradiation. The prevention of goiter by the administration of iodine to children will undoubtedly lessen the number of cases of adenomatous goiter with toxicity, but for the present we must deal with thyrotoxicosis by the most effective and positive method of treatment available to us. We must consider as mortality from treatment not only the immediate mortality from the method, but the remote mortality from incomplete cure and its effects, particularly on the heart.

If surgery is the most favorable form of treatment in the severe complicated cases who are bad surgical risks, it should also

be the treatment of choice in the early favorable cases. I believe that at present the most effective and satisfactory treatment of exophthalmic goiter is the surgical removal of the thyroid after a preliminary course of iodine therapy. While the place of irradiation will naturally vary according to the type of surgery a patient is likely to get, I should personally advise its use only under exceptional conditions, reserving it for certain mild and doubtful cases, and for a few individuals where some economic or personal factor makes the use of surgery inadvisable. We have also found it useful as an alternative to further operation in certain cases where an insufficient amount of thyroid tissue has been removed, to bring the metabolic rate to within normal limits.

While the previous outline embodies my own views as to the place of surgery, medicine, and irradiation in exophthalmic goiter, it is supported in general by the opinion of our Thyroid Committee. In a paper (6) before the Massachusetts Medical Society last June, by members of the Committee, the following statement occurs: "Our conclusion at present, therefore, is that iodization followed by subtotal thyroidectomy, while the metabolism is normal, is the best program for the treatment of exophthalmic goiter that has yet been advanced. Roentgen ray will still have its place with patients in whom, for any reason, operation is inadvisable, or who refuse operation."

This conclusion is borne out by actual practice at the Massachusetts General Hospital. After a trial of both roentgen ray and surgery over a period of five years, during which results were observed by a balanced committee representing the roentgen-ray, medical and surgical departments, the majority of cases are now treated by rest in bed during a period of from eight days to two weeks, during which time the patients ordinarily receive fifteen minimis of Lugol's solution daily, followed by subtotal thyroidectomy in one or occasionally in two stages. This program has been adopted, not because surgery is an ideal treatment of exophthalmic goiter, or because irradia-

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tion with the roentgen ray is without effect, but because on the whole the patient's interests appear to be best served by the greater certainty and rapidity of the results thus obtained.

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Annular shadows.—The author states that these shadows are produced most often by simple subacute or chronic localized pleuritis which may or may not be associated with umbilication or puckering of the subjacent lung tissue and consequent localized separation of the pleural layers; the resulting interstice may contain freely movable fluid. While lung rupture may on rare occasions result in a pocketed pneumothorax of circular or spheroidal shape, it is not probable that this mechanism is by any means the usual explanation of the densities in question, which are of fairly frequent occurrence. In chronic progressively or intermittently active tuberculosis they may appear in more than 10 per cent of the cases. One proven feature of pleural rings is that they usually develop and increase in size as accompaniments of active pulmonary disease and diminish or disappear as this becomes quiescent or healed.

Pleural annular shadows develop, without any demonstrable rarefaction of intra-pulmonary densities, usually in the upper and posterior parts of the chest or in the planes of the interlobar fissures. The inner border is practically always sharply defined while the outer one fades off, sometimes extending as a diffuse cloud over wide areas of the field or as a pleural cap enveloping the apex. Through the ring unbroken pulmonary markings can be distinctly visualized. It is a frequent occurrence to find pleural annular shadows shrinking rapidly and finally fading from the picture; such a change may be effected in a few weeks or months. At the same time there is no change in the underlying pulmonary densities, save the usually orderly slow healing.

If the roentgenogram shows a single doubtful annular shadow without any other rarefaction,

and the patient has sputum with tubercle bacilli, that shadow probably represents true cavitation, which may or may not give physical signs. If, on the contrary, a sizable annular shadow appears and the patient has no tubercle bacilli in his sputum or no sputum, the lesion is probably pleuritic.

J. D. CAMP, M.D.

The Nature and Differentiation of Pleural Annular Shadows. J. Burns Amberson, Jr. *Am. Jour. Roentgenol. and Rad. Ther.*, Nov., 1924, p. 438.

Rickets.—The prevalence of mild rickets in the Pacific Northwest has led to a search for early clinical signs. The head and chest furnish the first skeletal evidence of the disease. Craniorabes was demonstrated in 60 per cent of the winter babies; its existence is most easily determined at the mastoid fontanel. Among abnormalities of the chest indicating rickets are the square, triangular and oval forms, as measured at the plane of the fifth costochondral junction. Costomalacia, or softening of the sternal ends of the ribs, appears during the first four months of life and is an important clinical sign. Both genu valgum and genu varum are always preceded by abnormal lateral motility of the knee joint, which is often the first sign of leg rickets. Knee motility can be measured approximately by hand or accurately by means of a very simple apparatus. Determining the amount of motility has proved valuable for both diagnosis and prognosis.

W. W. WASSON, M.D.

Newer Clinical Signs of Early Rickets. C. U. Moore. *Jour. A. M. A.*, Nov. 8, 1924, p. 1469.

A COMPARISON OF THE RESULTS OF SURGICAL AND ROENTGEN-RAY TREATMENT OF EXOPHTHALMIC GOITER¹

By ARTHUR C. CHRISTIE, M.D., WASHINGTON, D. C.

WE recognize the fact that the roentgenologist who stands as a proponent of the roentgen method of treatment of exophthalmic goiter as opposed to surgical treatment is entering upon controversial ground. The surgical treatment of this disease is so firmly established and its results are so much superior to any method previously used that surgical writers may be excused for a somewhat intolerant attitude towards a new method, and especially towards a new method that has not yet been in use for a sufficient length of time to enable it to present a body of statistical proof of its effectiveness.

The object of this paper is to present a summary of a somewhat careful examination of the published results of the surgical treatment of exophthalmic goiter and to compare them with the results of roentgen treatment.

The history of the surgical treatment of Graves' disease covers practically the entire history of the development of general surgery. One can scarcely think of the disease without recalling the names of Graves, Basedow, Stokes, Charcot, Troussseau, Kocher, Mikulicz, Halsted, and others. The first operations performed for hyperthyroidism were probably those of Tillaux and Rehn in the early eighties. In spite of the great pioneer work of Halsted in this country during the nineties, it cannot be said that the surgical treatment of exophthalmic goiter had received the general approval of the medical profession until some time after the beginning of the present century. Those of us who graduated in medicine about the year 1900 remember very well the pronounced and widespread opposition of internists to the surgical treatment of this disease. It was, in fact, at least thirty years, and probably longer, after the first operations for the relief of thyrotoxi-

cosis before there was any general acceptance of this method of treatment in the United States. After that time, however, the rapid improvement in technic, the substitution of subtotal thyroidectomy for lobectomy, the improvement in the general management of patients, the performance of preliminary ligations, and above all, the accumulation of statistics showing a great number of cured cases, all together served to establish surgical treatment as the method of choice.

I call attention to this very gradual acceptance of surgery in order to show the difficulty of establishing a new method of treatment and to point out the unwisdom of condemning a method because its early results are not in the nature of conclusive proof. There is a close parallelism between the former attitude of the internist towards surgical treatment of exophthalmic goiter and the present attitude of the surgeon towards the roentgen treatment of the same disease. The same argument formerly used by the internist against the surgical method is now employed by the surgeon against the roentgen method of treatment, *viz.*, "you can show us no adequate statistical proof that as many or more patients are cured by the new method than were cured by the old."

In order that we may form some opinion of the actual value of statistics in this disease I wish to bring to your attention some of those that have been compiled to show the results of surgical treatment. Crotti, in his book on "The Thyroid and Thymus," gives a table of the published results of surgeons in all parts of the world from 1894 to 1922. There has been a gradual increase in the percentage of permanent cures and a gradual reduction in the operative mortality during these years. Since 1912 the statistics seem to show distinct improve-

¹ Read before the Radiological Society of North America at Kansas City, December, 1924.

ment in both these respects over those published previous to that time. For that reason I have chosen for examination only the figures published since 1912, because they represent about the results to be expected from present methods of treatment.

Crotti's table shows 16,754 cases since 1912, but 7,359 of these were compiled from the literature and presumably are largely composed of cases operated upon before 1912. Eliminating these we find that the average percentage of permanent cures in over 9,000 cases is approximately 60 per cent, and that there is an additional 25 per cent of cases showing marked improvement. There were about 10 per cent showing no improvement at all and a little over 4.5 per cent of operative deaths.

Statistics from the Mayo Clinic compiled by Judd in 1920 show 65.8 per cent of cures, 13.6 per cent markedly improved, 5.6 per cent slightly improved, and 15 per cent dead from all causes.

The statistics of operative mortality in exophthalmic goiter vary immensely with different operators. In the table given by Crotti the death rate varies from zero to 13.1 per cent. The latest report from the Mayo Clinic gives an operative mortality of 1.77 per cent; other operators, among whom are Crile and Lahey, state that their operative mortality is approximately 1 per cent.

There is no doubt whatever that there has been a striking reduction in the immediate mortality following operation for exophthalmic goiter from the days when it was 15 to 20 per cent in the best hands to the present time when it is 1 to 3.5 or 4 per cent. It is not out of place to point out that there is always a great discrepancy between the results that might be obtained throughout a country if all patients were operated upon by the most skillful surgeons under ideal conditions and the results that are actually obtained by surgeons of all degrees of skill operating under all sorts of conditions. There is perhaps no disease in which the personal equation is so important as in exophthalmic goiter. It is un-

fortunate that only a few of the total number who have this disease are operated upon in well-organized clinics by surgeons who have developed special skill in the technic of this operation. This is the practical fact, however, that we must face, and it serves no good purpose to maintain that the operative mortality obtained in great clinics represents the real conditions existing throughout the country even among the average good surgeons. Not only the published statistics but the general experience of those who see many cases of exophthalmic goiter indicates that the operative mortality throughout this country is nearer to 5 per cent than it is to 1 per cent. We are certain that it cannot be lightly set aside as of little or no importance. This is the first fact that we must take into consideration in comparing surgery with any other method of treatment.

We must next inquire what percentage of patients are cured or improved by surgery. I have already mentioned the statistics compiled by Crotti showing an average of 60 per cent of permanent cures and 25 per cent markedly improved, and those from the Mayo Clinic with 65.8 per cent of cures and 13.6 per cent markedly improved. It is quite likely that approximately 60 per cent of permanent cures and 15 to 25 per cent of markedly improved cases is about what may be expected of the surgical treatment of exophthalmic goiter, taking this country as a whole.

This is in distinct contrast to the prevalent opinion that thyroidectomy is an almost certain cure of Graves' disease if the patient survives the operation. That surgeons have no such optimistic outlook is shown by the following quotations from Hertzler:² "Even in the study of one's own results the difficulties are many. I am becoming more skeptical as to the prognosis the more closely I study my patients. Like operating on malignant disease, the operative recovery is only a part of the story. Nearly all patients operated upon show

² Hertzler, Arthur E.: Diseases of the Thyroid Gland. C. V. Mosby Co., St. Louis, 1922, pp. 125-126.

post-operative improvement. In some instances the patient thinks herself well and writes glowing accounts of her improved condition. Reports by correspondence are of limited use. Often those that report by letter that they are quite well will be found on examination to have some of their old symptoms

"Statistical records correct to-day may be all wrong at some future date. Frequently the improvement lasts many years and then a relapse comes. One of my patients remained symptomatically well for more than ten years, then died of acute thyrotoxicosis. The longer one observes his patients, the less the percentage of cures. One by one, in the lapse of years, they step from the cured group. I have seen many patients operated upon by other surgeons who come, after several years of improvement, with a relapse. They state that the surgeon does not know of their renewed trouble. Therefore, that surgeon has her on his records as a cure. No doubt some of my 'cures' are telling of their renewed trouble to some sympathetic surgeon"

The same author continues, with regard to post-operative prognosis, with the following somewhat naïve remark: "The best that can be said of the operative treatment is that it is the best that we have to offer the patient. Aside from active interference our efforts are not brilliant; surgeons can well afford to be truthful in their statements and conservative in their estimates, for they alone can speak with confidence of having rendered aid."

There is perhaps no one in better position to-day than the roentgenologist to speak of the failures of thyroidectomy to cure exophthalmic goiter. The recurrent cases after operation form a definite percentage of those treated by every roentgenologist. It is also of importance to note that recurrence usually takes place a year or more after operation. The very prompt improvement in all of the clinical symptoms and a sharp drop in the basal metabolic rate immediately following operation are likely to give a false sense of security which is found

unjustified if patients are kept under much longer observation. Statistics of cure are greatly reduced in value because many recurrent cases, due to disappointment and discouragement, fail to return to the surgeon who performed the operation. They either go to another surgeon who has difficulty in persuading them to submit to another operation, or they seek some other treatment.

There is one other consideration that must be given a certain weight in any attempt to evaluate surgical statistics of exophthalmic goiter. This is the fact that a certain percentage of patients are inoperable, either because of the acute stage of the thyrotoxicosis or because of the presence of some other disease. In the past, as surgeons have decreased their percentage of inoperable cases, their mortality rate from operation has shown a coincident rise. It is true that because of perfected technic, graded operations, and, recently, the pre-operative administration of Lugol's solution, fewer cases are in the inoperable class. In the past, however, from which our statistics are drawn a considerable percentage of patients have been considered inoperable, so that it must be understood that the surgical cure of 60 per cent of cases of exophthalmic goiter means the cure of 60 per cent of those operated upon and not of the total number seen.

There is a further discrepancy that is inherent in the statistics of all diseases but which has been a particular source of error in Graves' disease. This consists in errors in diagnosis. Mistakes were more common in this respect before we had metabolism measurements to depend upon. There is no doubt that operative statistics of exophthalmic goiter contain many cases of psychoneuroses and non-toxic goiters, adding another element to their unreliability.

The following, then, seems to be a fair statement of what surgery has accomplished in this disease since the year 1912. It has brought about a permanent cure in approximately 60 per cent of the patients operated upon, and marked improvement in an addi-

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tional 15 to 25 per cent. This has been accomplished with an operative mortality varying from 1 per cent in the best hands, to a very high percentage in less skillful hands, with a probable average among good surgeons the country over of 3.5 to 4 per cent. There is also a certain indeterminate percentage that are inoperable.

The roentgen ray has been used for the treatment of exophthalmic goiter since 1898. There is no need to review our knowledge of the biological effect of the roentgen ray which renders its use in this disease a rational one, nor to describe the technic now in use. It was not until the advent of the Coolidge tube in 1913 that we were able to control and duplicate roentgen-ray dosage. Since 1915 we have had in this country what may be considered a somewhat standardized dose, which is that recommended by Pfahler in that year. This indicates at once the necessity for confining our discussion of the roentgen treatment to the results obtained in the past seven or eight years, and shows that this method is still in its infancy. The statistics that are available are in much the same state as those of the surgeon; that is, those from different sources show such great variations that they are hardly comparable, and averages made from them have no real practical value. We must still judge of the results of this method of treatment from those obtained by competent individual workers, and there are now available reports from a considerable number of such workers in widely separated localities in this country. The uniformity of these reports is striking. They are, in fact, practically unanimous in their opinion that a majority of cases of exophthalmic goiter are improved by roentgen treatment and that a large percentage,—most observers believe more than half,—can be cured. Contrary to the opinion expressed by most surgeons that a very large percentage of cases treated by the roentgen ray fail to show improvement, it is the experience of roentgenologists that the majority of cases treated do show definite improvement. It is the uniformity and regu-

larity with which such improvement occurs that constitutes the most convincing proof of the benefit of roentgen treatment in this disease. Our own experience in this respect is well illustrated by the following summaries of cases:

Case 1. Miss J., aged 18. A well-marked case of exophthalmic goiter with all of the classical symptoms. Basal metabolic rate, plus 72 per cent. She was given four roentgen treatments, the first on Nov. 11, 1922, and the last on Jan. 29, 1923. On March 17, 1923, the patient had gained 8 pounds in weight, the tachycardia had completely disappeared and the basal metabolic rate was plus 10.5 per cent. During the next year she had a gain of another 8 pounds in weight, the thyroid enlargement greatly decreased, exophthalmos became scarcely noticeable, and the tremor ceased. The patient has remained perfectly well up to the present time in spite of the fact that she married, became pregnant, and nursed a healthy baby.

Case 2. Mrs. C., aged 31. Had thyroidectomy twelve years ago, preceded by ligation. The symptoms at that time were those of exophthalmic goiter, with severe toxic symptoms. Two years later she was married and has borne five healthy children. About six weeks before examination she had an attack of grippe, with fever and cough. Present condition dates from that time. There is now slight fullness of the neck in the mid-line, moderate exophthalmos, marked tremor, visible pulsation in the neck, moist skin, and anorexia. She has lost 8 pounds in the past ten days. Basal metabolic rate, plus 55 per cent. This patient had three roentgen treatments—on Feb. 15, March 8, and March 29, 1923. On the latter date she had gained 12 pounds in weight, that is, within a period of about six weeks and following only two roentgen treatments. She was last seen on May 6, 1924, and had remained entirely without symptoms to that time, and was able to attend to all the duties of her home.

Case 3. Mrs. F. C., aged 43. Had always had good health until five weeks previ-

ous to examination, during which period she has felt weak and tired out and has lost 30 pounds in weight. Has had nausea and vomiting, but no abdominal pain. She has no desire for food and has had diarrhea. Has a marked tremor of fingers, lips, and eyelids. She is very restless and sleeps poorly, constantly moving about in bed. She has noticed an enlargement of the neck ever since she was a girl and does not think it has increased lately. The enlargement of the thyroid is confined to the right lobe. No exophthalmos. Pulse, 120; basal metabolic rate, plus 50 per cent.

The diagnosis in this case was toxic adenoma. The toxic symptoms were so marked, including vomiting, diarrhea, cardiac irregularity, and swelling of the feet, that the patient was kept in bed for a period of six weeks. During this time she received three roentgen treatments, with gradual improvement in the symptoms and slight decrease in the basal metabolic rate. At the end of another three weeks she received the fourth and last treatment—on Oct. 19, 1923. On May 2, 1924, she was free from all symptoms. She looks and feels well. Has gained markedly in weight, weighs 160 pounds. Sleeps well and is not nervous. There is no tremor. Pulse, 68; basal metabolic rate, zero per cent.

Case 4. Miss A. D., aged 24. A typical case of exophthalmic goiter with symmetrical enlargement of the thyroid, exophthalmos, tremor, tachycardia, and loss of 24 pounds in weight. Basal metabolic rate, plus 91 per cent. This patient was kept under very close observation for ten weeks, most of the time in bed. During this time she received four roentgen treatments. After the fourth treatment all of her symptoms were greatly relieved and the basal metabolic rate had dropped to plus 39 per cent. After this she received four additional treatments at longer intervals, carefully checked by the basal metabolic rate. The first treatment was given on Aug. 1, 1923, and the last on Feb. 16, 1924. Even when the last treatment was given the basal metabolic rate was still plus 21 per cent,

but it steadily decreased during the next three months without further treatment until it was plus 2 per cent on June 25. She has remained free from symptoms to the present time; eats well, sleeps well and has gained 38 pounds in weight.

This is the usual type of patient that is operated upon after three or four roentgen treatments are given and which seems to justify the surgeon in stating that the roentgen ray fails to cure in a large percentage of cases. The argument is that even if the patient is ultimately cured by roentgen treatment it can be done much more quickly by surgery. This is, however, open to question. The type of case that the roentgen ray is slow in curing is usually the type that is either inoperable or in which graded operation must be performed. In addition to this consideration, these are the patients who furnish most of the deaths in the surgeons' statistics. It is also contended that the length of time it takes for such patients to get well adds to the mortality and chronic morbidity because of the increased opportunity for cardiac and other visceral changes to occur. Our own experience indicates that this is a theoretical rather than a practical danger. In the last case cited above, there is no clinical evidence of any cardiac damage or visceral degeneration. Quite uniformly in our experience the toxic manifestations are under control within six weeks, that is, after the third treatment. A considerable percentage of the cases require only three treatments, and it is rarely that more than six must be given. The longer time necessary for a cure of hyperthyroidism by the roentgen method over that required by surgery is compensated for by the fact that the patient under roentgen treatment is usually able to continue with her work, at least to some extent. This, together with the fact that large hospital expenses are eliminated, is an important consideration from the economic standpoint.

We have now seen results in a large number of cases similar to those reported above and the regularity with which these results are obtained has convinced us that this

method of treatment will cure a large percentage of cases of hyperthyroidism.

The word "cure" is used here in the same sense that the surgeon uses it, meaning constant freedom from any evidence of thyrotoxicosis. We are still entirely ignorant of the cause of exophthalmic goiter and so long as that is true we must depend on such empiric methods as surgery and the roentgen ray to destroy the hyperplastic glandular structure.

SUMMARY

We may summarize what we believe to be the present status of the treatment of exophthalmic goiter by surgery and by the roentgen ray as follows:

1. Surgery effects a cure in approximately 60 per cent of the cases operated upon and brings about marked improvement in an additional 15 per cent. There is a certain unknown percentage inoperable and an operative mortality of 1.5 to 4 per cent. These appear to be the facts based

upon a large number of cases operated upon.

2. The roentgen ray effects a cure in a considerable percentage of cases, but just what percentage is still unknown. That the percentage is in all probability as high as that of surgical treatment is the opinion of roentgenologists who have treated a large number of cases. This opinion is based upon the uniformity and regularity with which improvement takes place, as well as upon a considerable number of cures already reported by many different men. The roentgen ray has the additional advantage of being available in inoperable and post-operative cases. It must be admitted that roentgenologists cannot yet offer convincing statistical proof but there is sufficient evidence at hand to fully warrant continued use of the method. It is our belief that it should be used not only in inoperable and post-operative cases but that it should be given a *thorough* trial in all cases, and that only those cases should be operated upon that fail to respond to roentgen treatment.

Artificial pneumothorax.—In the treatment of pulmonary tuberculosis by artificial pneumothorax the time during which the lung should be kept compressed varies with each individual patient. One of the most difficult questions for decision is to estimate when the lung may be allowed safely to expand. Such a decision is, as a rule, irretrievable, because in the majority of cases adhesions soon form between the lung and the chest wall, so that no recompression can be effected. The writer reports this case therefore because of the unusually long interval of six years and six months between the last refill for artificial pneumothorax and a fresh induction. The disease was shown to be definitely tuberculous by the finding of the tubercle bacilli

in the sputum. An additional point of interest is the fact that there was an entire absence of adhesions and a complete collapse of the lung was obtained, as shown by the roentgenogram. This is all the more unusual in view of the history of a pleurisy and the presence of a pleuritic rub prior to the first induction of pneumothorax. The author stresses the advisability of attempting to carry out an artificial pneumothorax when indicated, despite the deterrent influence of the medical history.

SOLOMON FINEMAN, M.D.

Recompression of a Tuberculous Lung by Artificial Pneumothorax. R. C. Hutchinson. *Lancet*, Jan. 10, 1925, p. 74.

X-RAY TREATMENT OF THYROTOXICOSIS¹

By ROBERT G. ALLISON, M.D., Assistant Professor of Roentgenology, University of Minnesota Medical School

NUMEROUS objections have been offered to the roentgen treatment of hyperthyroidism, as follows:

1. Hyperthyroidism has a tendency to recovery under rest alone.

While this is undoubtedly true, I fail to see why it should apply to cases undergoing roentgen treatment. These cases are almost invariably ambulatory and even working, while cases undergoing surgery almost always have a prolonged rest in bed. The analogy is perfect between the surgeon who ascribes the roentgen cures of toxic goiter to Nature and the one who gravely speaks of the natural tendency of peptic ulcers to heal spontaneously when confronted with a successful Sippy cure; and that much more perfect when both continue to perform subtotal thyroidectomy and gastro-enterostomy.

2. X-ray burns may occur.

With a standard technic the occurrence of an X-ray burn implies the omission of the filter. If the filters are screwed into the tube stand they cannot be omitted. Granting that some X-ray burns do occur, their mortality rate would compare most favorably with the operative mortality of hyperthyroidism.

3. The treatment accomplishes nothing.

The carefully compiled statistics of scores of careful observers over a period of years refutes this individual opinion.

4. The treatment may result in myxedema.

I think this unconscious tribute will be gratefully accepted by most roentgenotherapists. It at least implies that the treatment is efficacious in some cases. The few cases of myxedema which appear in the literature as occurring during roentgenotherapy are of a transient nature. A speedy return to normal under small doses of thyroid extract is noted in all of the cases. With the basal metabolic rate as a control, it is not logical to expect myxedema to occur.

5. Some remote physical effect may occur from so powerful and so little understood a therapeutic agent.

We do not fear this "remote physical effect" in the roentgen treatment of tuberculous cervical adenitis. Areas of the same size are exposed to the same amount of radiation in this condition and in hyperthyroidism. The roentgen treatment of hyperthyroidism has been used for twenty-three years without the occurrence of any bad physical effect, remote or otherwise.

6. The authority of the surgical clinic is lessened by having to offer an alternative type of treatment.

If the alternative type of treatment can show a reduction in the mortality rate over that of surgery, then it would seem wise to lessen the authority of the surgical clinic to the extent of giving the alternative type of treatment a fair trial.

7. Patients are so much improved that they refuse surgery, but are still not entirely well.

If surgery were a panacea for hyperthyroidism and were without danger, this would be a serious objection to roentgen treatment. We should consider, however, the fact that these cases have been markedly improved without being subjected to the hazard of an operation. Thorough co-operation between surgeons, internists and roentgenotherapists, resulting in an unanimity of opinion, will usually result in the patient doing as advised.

8. Patients become dissatisfied with roentgen treatment and go elsewhere for surgery.

This factor can usually be prevented by the roentgenotherapist being willing to change to surgery whenever he is convinced that his treatment is failing or that his patient has lost faith in the treatment. Certainly he cannot hope to obtain a favorable result in treating a dissatisfied patient.

¹ Read before the Radiological Society of North America at Kansas City, December, 1924.

My experience with the roentgen treatment of hyperthyroidism dates from January, 1920, since which time I have administered one or more treatments to one hundred and seventy-five cases of varying degrees of severity.

From January, 1920, to January, 1921, in co-operation with two internists, I undertook the treatment of twenty-seven consecutive cases of hyperthyroidism entering the dispensary and medical ward of the University Hospital and the private practice of the two internists. We reported on these cases, all of a mild and moderate degree of severity, in September, 1921, eight months after treatment had been completed on the last case. The substantial basal rates at the beginning of treatment ranged from plus 17 to plus 71, the average rate being plus 33. An average of five treatments per case was administered at intervals of three weeks.

Twenty-one (78 per cent) of the cases showed an apparent cure, when checked clinically and by basal metabolism at a minimum period of eight months after the last treatment. Three (11 per cent) were markedly improved. The remaining three (11 per cent) were not markedly improved and were operated upon. Prompt cures resulted from surgery to each of these three cases. Changes in the medical personnel of the hospital and dispensary have prevented a continuance of the "follow-up" on this series of cases and have further prevented adequate control of the numerous cases treated since that time.

Not until our teaching hospitals establish thyroid clinics modeled after the one we have at the Massachusetts General Hospital will we be able to draw unbiased conclusions as to the relative merits of different types of therapy in hyperthyroidism, for it is to these teaching institutions that we must look for accurate statistics. Private clinics are almost invariably dominated by the chief of the surgical service, who has the final word as to the type of therapy to be carried out. The roentgenotherapist in private practice has a problem which is almost

insurmountable. The average surgeon who refers to him a case of hyperthyroidism for treatment is not interested in the ultimate success of the treatment; his object is to get the toxicity of the goiter so reduced that the patient is not likely to die when operated upon. When such a case has its toxicity markedly reduced in two or three treatments, is operated upon, recovers, and is later reported as a failure by roentgenotherapy and a cure by surgery, the value of such statistics becomes apparent. The problem is nearly as difficult when a case is referred by the average general practitioner. He is generally willing and desirous of shifting the whole responsibility for the care of the case to the roentgenotherapist. This results in the latter having to arrange for the taking of the basal metabolic rate and watching the clinical course of the disease, as well as recognizing intercurrent diseases when they occur. Such a superman may exist, but it has not been my good fortune to encounter one.

What I have said is in no way intended to refer to the careful and conscientious surgeon or to the capable internist with a well-equipped clinical laboratory. However, the large percentage of the cases of hyperthyroidism which are referred for roentgenotherapy come from surgeons who are over-anxious to operate at the first favorable moment or from general practitioners who, from lack of time or lack of training, are unwilling or incapable of intelligent co-operation in handling the case.

Perhaps the roentgentherapists have been over-enthusiastic regarding their method of treatment. If so, I believe it is due to the intolerant attitude of surgeons toward a line of treatment which has invaded a domain which they consider their exclusive property. This attitude on the part of surgeons has resulted in the roentgentherapist continuing treatment in certain cases which might better be operated on. Nothing is easier than to become over-enthusiastic over a special type of therapy in which one is deeply interested. For this reason I believe that to obtain an unbiased

opinion of the relative merits of surgery and roentgenotherapy, the make-up of committees for such study should not have a preponderance of either surgeons or roentgenotherapists.

The selection of cases for one type of therapy or the other is of the utmost moment. We will all wait with lively interest the final report of the Thyroid Committee of the Massachusetts General Hospital on this point. Richardson states, in the body of one of his articles, that it is impossible to predict the effect of the roentgen ray in any given case. In his conclusions in the same article he states that the use of the roentgen-ray treatment for four months in selected cases is justifiable. Apparently his only contra-indication to a trial of roentgenotherapy is in the case showing organic damage, particularly cardiac. He states that this type of patient needs the certain

relief from toxemia that can be assured only by surgery. We will all agree that this type of patient needs immediate and certain relief from the toxemia. There will be some disagreement, however, over whether surgery offers certain relief. At the present time I have under roentgen treatment, six cases who did not get relief from surgery and who are getting precious little relief from roentgenotherapy.

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Abnormalities of the colon.—Congenital anomalies of the colon, such as redundancy, have heretofore been largely the concern of the anatomist and the surgeon. The clinical significance of these malformations is the basis of this work, which is based on 62 cases in a series of 688 gastro-intestinal roentgen examinations. Redundant colon is by no means a rare anomaly. It occurs in from 9 to 14 per cent of all persons and in 23 per cent of all constipated individuals. It is more common in sthenics than in asthenics, in men than in women.

Symptoms are brought on by strain or injury or by abuse of colonic function. Redundant loops are in themselves not necessarily obstructive to the passage of feces, but may become so under certain conditions of localized stasis or sudden changes in posture with or without interference with blood supply. Perhaps two-fifths of all cases of redundant colon show no symptoms.

Constipation and gas distress are the most common symptoms. Pain is almost as common.

Volvulus, though rare, considering the frequency of the condition, occurs only in redundant bowels.

The diagnosis is made by roentgen examination. The differential diagnosis is from gall-bladder disease, appendicitis, cancer of the colon and cardiovascular disease.

The therapy consists in the restoration of colonic function where this is decompensated, and otherwise in non-interference. Vicious cathartic and enema habits should be discontinued. Spasticity should be overcome by rest, lubrication, and anti-spasmodics. Surgery is not indicated for redundancy as such and should be reserved for superimposed accidents such as twists or torsions.

J. D. CAMP, M.D.

A Clinical Study of Some Common Anatomical Abnormalities of the Colon. I.—The Redundant Colon. John L. Kantor. Am. Jour. Roentgenol. and Rad. Ther., Nov., 1924, p. 414.

RADIUM TREATMENT OF THYROTOXICOSIS¹

By R. E. LOUCKS, M.D., DETROIT, MICHIGAN

In treating an organ or gland dysfunction of uncertain etiology, your efforts are largely empirical, although the control or alleviation of painful or dangerous objective and subjective symptoms and the prevention of critical sequelæ are justifiable under all conditions.

In all types of new treatment, the early results must be, to some extent, discounted, unless controls are used; and it is not until a large number of cases have passed through the hands of competent clinical observers, that one can arrive at any definite estimate of the value of the treatment.

The difficulties of comparing accurately any given number of cases with any other similar number under a different treatment, are considerable, because so many factors in the physical makeup are different that the careful clinician is obliged to check the results by observations and clinical tests, and base his views and opinion on a general comparison of their results with those obtained from other forms of treatment—usually in the past.

The recollection of other cases of a similar nature, which were treated in some other way, surgical or otherwise, and the approximate time in which they recovered, with established results, is compared with the approximate time similar cases require under the new treatment.

The active support of the defensive mechanism and preventative measures generally should, in all cases, be the fundamental method of attack. Symptomatic treatment should be regarded as a secondary, but a very valuable, adjunct.

The thyroid gland, being the keystone of the arch or circle of the so-called endocrine glands, holds the balance of physiological activity in health, which we term metabolism. The importance of the gland is manifest by the rich blood supply, location and sympathetic nerve control. Plummer has

proven that one of its chief functions is to manufacture a hormone called *thyroxin*, which is continuously poured into the blood stream. In health, the over-supply is stored within the gland as colloid material for a physiological emergency. Functional derangements of the thyroid gland may take place from early childhood to extreme old age (not including malignancies at this time). It has been experimentally and conclusively shown that deficiency in iodine produces a compensatory hyperplasia of the gland, in an effort to produce more of the element for physiological purposes, giving what is termed a simple parenchymatous goiter. This condition responds to medical and hygienic treatment, if recognized and treated early. If the exciting factor is continuous and the condition uncontrolled, the simple hyperplasia passes to a hypertrophy and adenomata, with or without cystic formation and colloidal retention. The new-growth may remain quiescent for years, and apart from its disfigurement and pressure symptoms, the host will have no toxic effects from its presence.

Infection is met in the first instance with a defensive response by (1) an accelerated metabolism, which is not a specific in itself but a "rier" to mobilize the necessary defensive processes; and (2) the bacterial toxin which irritates or stimulates the thyroid gland to overact.

Should the infection or sepsis become chronic, so that there is a continuous call upon the endocrine system, the balance of metabolism is broken by the hyperactivity of the thyroid gland; it would therefore be necessary not only to treat the focus of toxic absorption at this time, but also to recognize at the same time the possibility of an endocrine lesion.

Plummer has found that the leukocyte formula is altered in hyperthyroidism by a low polymorphonuclear count and that the

¹Read before the Radiological Society of North America, at Kansas City, December, 1924.

metabolic rate is raised by excess of thyroxin.

Schafer concludes from experimental evidence that toxic goiter is not a simple oversecretion of the normal thyroid hormone, but that the substance secreted is an abnormal one. After classifying the case pathologically as toxic goiter, the indications for radium treatment are manifest, unless some symptomatic relief is urgent.

For nearly four years all cases have had the metabolic rate taken before the radium treatment, and every six months afterwards until the rate was normal. Metabolism being the unit of toxic activity, the rate will verify the clinical findings, prove the results of the treatment, and give indication for future measures. It was found that the metabolism was raised for the first two months after treatment, but many cases gave a normal rate at six months, while others required a year or more. Any case showing a metabolism of plus ten after eighteen months was given a smaller treatment over what was apparently the active part of the gland. The diastolic blood pressure, usually low in hyperthyroidism, rises gradually following radium treatment, which is a positive indication of improvement in the toxic symptoms. If the systolic blood pressure is too high, it is lowered by treatment, unless there is extreme cardiovascular disease.

Should radium treatment be given during a very active stage of the disease, when all the symptoms of toxemia are at the peak, the nausea, tachycardia, sweating, etc., will not subside for three or four weeks, but symptomatic relief can be obtained by using the ice bag over the thyroid gland and precordia, giving digitalis, bromides and alkalies, and insisting upon complete rest in bed.

The tremor usually begins to subside after six weeks, and is one of the first symptoms to show improvement. The tachycardia responds in direct relation to the amount of damage already done to an over-worked organic heart. When compensation is established in the dilated heart, and the toxemia is under control, the heart beats will be lessened one-quarter within two

months. However, in the old, long-standing case, with more or less organic change of the heart, the pulse rate usually remains high. One of the most positive indications of toxic control in hyperthyroidism is the gradual increase of body weight.

The technic of radium treatment of goiter, as given by the author four years ago, is so simple that I hesitate in repeating it, yet perhaps there are many here who are not familiar with the method. Clinical judgment in the use of radium is of foremost importance in all cases. Do not be imbued with the thought that you are all Davids and can kill everything with a small pebble.

Use 100 milligrams of radium element at least, and at times 150 milligrams or more, depending on the size of the gland. Screen the tubes with one millimeter brass and one millimeter rubber, and place them one centimeter apart on a gauze pad, two or two and one-half centimeters in thickness, depending on the subcutaneous fat and the time given. The gauze pad is made with a loop of adhesive tape at each end, so that it can be adapted and tied over an uneven surface without strapping. The radium pad is placed over one lobe for eight or ten hours, and then over the other for an equal time, depending on the size of the lobe and the amount of radium used. If the isthmus is enlarged, the pad can be arranged to cover one side of it at each application, without overlapping and endangering the trachea.

If iodine has been used on the skin, a pad saturated with alcohol and starch water should be applied for a few hours before placing the radium package. Previous X-ray treatment also requires conservative judgment in screenage and time of radiation. At times subsidiary treatment is important after radiation, to control existing symptoms, as insomnia, tachycardia, vomiting, indigestion and diarrhea, until the therapeutic effect of the radium has been established.

To reiterate, the toxic thyroid gland is enlarged through hyperplasia and hyper-

trophy of the epithelial cells, and the increased amount of lymphoid tissue surrounding the lymph nodes. The question arises whether radium therapy diminishes gland secretion by direct action on the secreting cells, with some specific effect on thyroxin itself, or whether radium acts mechanically by blocking the blood supply.

The rapid control of the toxic symptoms after radium treatment would support the hypothesis of a change in the character of the secretions by direct effect on the secreting cells. Diminished secretion and reduction in size of the gland will come later, due to cellular change, while thrombosis of the smaller arterioles and capillaries will come last of all. Suffice to say, the results of radium therapy of toxic goiter are beyond comprehension.

CASE HISTORIES

Case No. 726, first seen January 29, 1921. Female, aged thirty-one years, married, mother of one child eight years of age.

Family history: Negative.

Past history: Had measles and smallpox when a child. Menstruated at thirteen years; always regular. Had left brachial cyst removed when seventeen, also had a tonsillectomy. Had an ovarian cyst removed five years before present examination. For the last two years has had "throat trouble." Had difficulty in breathing, and, when going upstairs, tracheal pressure. Severe headaches, fatigue and disinclination to work. Perspires freely, and at times has one or two degrees of fever. Appetite good; bowels regular; no insomnia. Has had some middle ear disturbance from eustachian infection.

Examination: No eye manifestations. Fragments of lymphoid tissue within the pillars of both tonsils so that the posterior pillars are adherent to the pharyngeal walls and show evidence of infection. The thyroid gland is enlarged; not cystic, but soft, causing a compression of the trachea. The left lobe extends beyond the sternomastoid muscle and adjoins the brachial cyst keloid

scar. The right is also enlarged but lies well behind the muscle. The area of heart dullness is normal in outline and no murmurs are detected. Pulse rate 110. Blood pressure: systolic 130, diastolic 80. Metabolic rate: Plus 24.1. Upper circumference of neck, $13\frac{3}{4}$ inches; middle, $14\frac{1}{4}$; lower, $14\frac{3}{4}$ inches. There is a tremor of fingers on extension; nails have longitudinal striae.

Diagnosis: Toxic adenoma.

Treatment: Local treatment for throat; rest; ice bag on neck, with quinine hydrobromid medication.

April 23, 1921: Throat much better, with some improvement in general symptoms. Metabolic rate, plus 13.5.

October 7, 1921: Improvement was only temporary, so that now all the symptoms are exaggerated. Headaches worse; tachycardia; pulse 120; some diarrhea. Metabolic rate, plus 40.4. Recommended radium treatment.

November 2, 1921: One hundred milligrams radium element were used with previously described technic over each lobe of the thyroid for ten hours, and 40 milligrams, in the same screening, held behind the jaw over each tonsil area for ten hours.

The patient made a satisfactory recovery, with complete alleviation of all symptoms. She moved to another city, so that I was unable to follow the course of the improvement.

December 7, 1922: After fourteen months of complete relief from all the old symptoms, the scar on the side of the neck has softened down and both lobes of the thyroid are apparently normal in size. The lymphoid tissue at the site of the right tonsil has disappeared and the left is healthy in appearance. Pulse rate 80; full and regular. Systolic blood pressure 122; diastolic 80; metabolic rate minus 2.1.

Case No. 1360, first seen November 8, 1923. Female, aged twenty-seven years, married.

Complaints: (1) Nervousness; (2) Shortness of breath; (3) Itching of the skin.

Family history: Negative.

Past history: Had tonsillectomy and appendectomy nine years before examination. Bore twins eight years previous to examination; menorrhagia for five years following birth of the twins, which was controlled by an operation. Was irregular for a year following the operation, but regular for the past ten months. Had a "nervous breakdown" after the death of the last infant.

Marital history: Menstruated at fourteen years. Married at nineteen years; one pregnancy, twins. She had uremic convulsions during the birth of the eight-month children, who lived only a few months.

Present history: The thyroid became active during the menorrhagic period. Was very ill at times but became better after the operation and when her menstruation became regular. Worry aggravated the condition, for at the time the children were born and afterwards died, her husband and father were in military service in France. Had X-ray and other treatments within the past year, with some benefit.

Examination: Skin an olive-yellow color, showing an old pigmentation; both eyes enlarged, the right more than the left. Von Graefe's sign positive; mouth and tongue negative. Neck enlarged over thyroid, the right lobe firm near the isthmus. No cysts felt on either lobe. Upper circumference of neck, 13 inches; middle, 14 inches; lower, 14½ inches. X-ray negative for substernal enlargement. Heart dilated towards the left; sounds regular, but a systolic murmur present. Radial pulse 100; apex beat 112. Systolic blood pressure 170; diastolic 80. Weight 123 pounds. Metabolic rate, plus 18.2. Tremor of hands and fingers on extension, with beads of sweat in both palms. No rash on body at present time.

Diagnosis: Toxic adenoma with exophthalmos.

Prognosis: Good.

Treatment: One hundred milligrams radium in usual screenage, held over the right lobe eleven hours, and over the left ten hours.

May 8, 1924: Been feeling very well for two months. Has none of her former symptoms. Sleeps well; good appetite; no indigestion, and does not fatigue easily, as she is carrying on her outdoor work in the Salvation Army.

Examination: Skin a lemon-yellow pigmentation. Eyes apparently smaller, but the right still larger than the left. Von Graefe and Stellwag's signs negative. Neck normal in size without evidence of former enlargement, measurements showing a decrease of an inch in size. No enlargement of heart. No murmurs. Apex beat 86. Systolic blood pressure 150; diastolic 90. Weight 126 pounds. Metabolic rate, minus 3.

Remarks: She has made an ideal recovery in six months. The slight exophthalmos is the only evidence of her former condition.

Case No. 1114, first seen February 20, 1923. Female, aged sixteen, single, student.

Complaints: (1) Nausea and vomiting; (2) Weakness; (3) Palpitation; (4) Tremor of limbs.

Family history: Negative, except that one sister had a toxic adenoma of the thyroid and was treated with radium two years ago, with splendid results.

Past history: Negative.

Present history: Was attending a private convent school where she had intensive musical studies. She became very nervous, lost her appetite, became generally weak and had attacks of vomiting. Compelled to return home, and the family physician concluded from her symptoms and basal metabolism that she had a toxic thyroid. At this time she has been treated with all the usual remedies, including rest in bed for three months, and still retains very little food. Has diarrhea occasionally; weak spells; fainting attacks, and all the symptoms of a critical condition.

Examination: An anemic and emaciated girl. Both eyes full, but not bulging, yet sclera showing as a very pale blue line between the cornea and eyelid. Heavy pulsa-

tion over great vessels in neck, but no thyroid enlargement. Radial pulse too weak to be counted. Apex beat 160. Systolic murmur which is probably hemic in origin. Tenderness over epigastrum, with extreme thinness of abdominal muscles. Tremor of hands, fingers, lower limbs and back muscles. Systolic blood pressure 80; diastolic 30. Weight 70 pounds. Metabolism, plus 20. Blood: Hemoglobin 80 per cent; R.B.C. 4,500,000; W.B.C. 9,000; hemoglobin index 0.8. Polymorphonuclears 68 per cent; small lymphocytes 38 per cent; large lymphocytes 3 per cent; eosinophile 1 per cent.

Diagnosis: Primary exophthalmic hyperthyroidism.

Recommended: Radium treatment.

Treatment: One hundred milligrams radium element in four tubes, screened as stated previously, and applied over each lobe of thyroid for eight hours.

November 26, 1923: The gastric symptoms gradually became better after the treatment and the administration of alkalies. Was able to sit up in six weeks; to walk and take gradual exercise in eight weeks. Visited my office three months after treatment, and had gained three pounds in weight. Now, eight months after treatment, she has none of her toxic symptoms, has gained twelve pounds in weight, and gives a metabolic rate of minus 2.

September 12, 1924: Present weight, 103 pounds, or a gain of 33 pounds. Feels perfectly well, except that she is easily alarmed. Eyes normal in appearance. No evidence of anemia. Menstruation established. Apex beat 80. No murmurs detected. She intends returning to college in two weeks to resume her musical studies.

Case No. 1200, first seen May 22, 1923. Female, aged thirty, married, housewife.

Complaints: (1) General weakness; (2) Palpitation; (3) Rapid loss of weight.

Family history: Negative except that mother died of leukemia.

Past history: Had a hip infection at four years of age. Good recovery. No other illness.

Marital history: Menstruated at fourteen years of age. Always regular. Married four years before present illness. One child, three years old. Menstruation re-established six months after birth of child.

Present history: For two months she has been gradually losing weight; feeling tired; has no ambition; is nervous, apprehensive and fatigued easily with housework.

Examination: Skin pigmented, a coppery brown in color. Both eyes enlarged, the right larger than the left. Mucous membrane of mouth pale, tongue tremulous; erupting a lower right wisdom tooth; tonsils healthy in appearance. Neck enlarged over thyroid gland. Both lobes prominent, with the right slightly larger than the left. The isthmus has two cysts, one above the other, which gives a direct pressure on the trachea. Pulsation of great vessels on right side of neck, but no bruit heard. Heart impact felt all over the anterior chest wall. No murmurs detected. Apex beat 120; radial pulse 120. Systolic blood pressure 100; diastolic 38. Weight 89 pounds. Metabolic rate, plus 21.6. Some visceropatosis, but not checked radiographically. Tremor of hands and fingers on extension, with trophic change of the nails.

Diagnosis: Toxic adenoma with exophthalmos.

Treatment: One hundred thirty milligrams radium element, with stated screening, held over the left lobe of thyroid for nine hours; then over the right one for ten hours.

November 22, 1923: Been feeling very well for two months. Has none of the old symptoms and considers herself well in every respect. Pigmentation of skin less intense, eyes apparently normal in size. Present weight 107 pounds, or a gain of eighteen pounds in six months. Pulse 76, full and regular. Systolic blood pressure 100; diastolic 60. Metabolic rate, plus 2.6. Thyroid enlargement reduced so that the left lobe cannot be palpated, the right only slightly enlarged, with a remnant of

one cyst of the isthmus remaining. Hands and fingers absolutely steady.

CONCLUSIONS

1. Increase in body weight and lessened tremor of the hands and fingers are the first signs of toxic control, and are usually noted about the sixth week after treatment.

2. More than half of the 278 cases treated with radium show no evidences of a former enlargement of the thyroid gland.

3. A high systolic blood pressure is lowered 20 to 30 per cent within two months, unless there is general arteriosclerosis.

4. The arrhythmia, tachycardia and cardiac hypertrophy are less evident after the third month, and gradually become negative symptoms of a former thyroid activity.

5. When a high metabolic rate and other symptoms of a toxic goiter have been controlled by radium therapy, within a few months, and hold for over four years, what further evidence is required to prove the efficacy of the element?

DISCUSSION

DR. RICHARDSON (closing): Dr. Christie spoke of an inoperable group of cases which would include presumably the cases in which operation seems too dangerous on account of toxicity, cardiac cases with decompensation, cases with associated diabetes, nephritis, or hypertension. Formerly very toxic cases of exophthalmic goiter occasionally came in, and died before any treatment could be undertaken, or were, at any rate, very bad surgical risks. Now by securing a remission with iodine, these cases can be operated on with relative safety. It is particularly important to operate on cardiac cases and thus relieve the strain on the heart from the active thyroid. The inoperable group of cases is to-day, I feel sure, very small. The argument for surgery in those cases which are handicapped by complications is that it is more certain. I assume that our results are average X-ray results, just as our X-ray department must

assume that our surgical results are average surgical results. While we get a certain percentage of brilliant cases and others greatly improved through X-ray treatment, we do not get the consistent results reported here to-night. I should hesitate to give you this viewpoint unsupported, but I have the general agreement of our Chief of the Roentgenological Service. I should be very glad if these cases could be turned over to the X-ray entirely, but before that can be done, it seems to me that the X-ray should show a series of cases a year, or, better, three years, after treatment with a metabolism that runs in 70 or 80 per cent of the cases below plus 15. I am very critical of the "improved" group of cases, showing a persistent metabolism of about plus 25, and feel that they should be classed as unsatisfactory results. These patients are unstable, and should be slowed down a little more than the average individual. It is better for them to have a metabolism slightly below normal.

DR. CHRISTIE (closing): I was very much interested in Dr. Tierney's statement of the theory that the syndrome of Graves' disease is due to an imbalance of the autonomic nervous system. We all agree with him, however, that we are entirely ignorant of the real cause of Graves' disease, and so are still at liberty to elaborate theories about it. What I wish to emphasize particularly is the fact that there has been considerable talk about "keeping our feet on the ground," and that the only solid ground we have to tread upon in treating this disease is the known fact that thyrotoxicosis is accompanied by hyperplasia of the thyroid gland or the production of adenomatous tissue which functions as the thyroid. There is also the additional fact, shown by the work of Plummer, Boothby and Sandiford and others, that the basal metabolic rate is a true measure of thyroid activity. The surgeon accepts this, and it is the experience of roentgenologists that the metabolic rate is consistently lowered by roentgen treatment.

My associates and I began the roentgen treatment of hyperthyroidism several years ago in a very skeptical frame of mind, treating only inoperable cases. We began to see good results in very serious cases and gradually extended the treatment to operable cases. We have come now to feel almost as confident of obtaining good results by roentgen treatment of exophthalmic goiter as in cases of uterine hemorrhage due to myomata or fibrosis of the uterus.

Dr. MacCarty states that we must not accept this method of treatment until we can show a great number of cured cases, comparable to those that surgery can now

show. If surgeons had taken such a stand twenty years ago there would be no surgical treatment of exophthalmic goiter at the present time. Twenty years ago I heard a discussion of a paper by Dr. William Mayo at the Cleveland Academy of Medicine in which he was criticized for recommending surgical treatment of exophthalmic goiter when his own operative mortality was 16 per cent. If surgeons were willing to accept a method twenty years ago in which their operative mortality was 16 per cent, it would not seem unreasonable to ask them to refrain from criticizing a promising method to-day in which there is no mortality.

Wave length experiments.—In order to obtain a limited beam of which the average wave length could be determined with accuracy, filters were used of sheet molybdenum and tantalum, the first 0.06 mm., the second 0.125 mm. in thickness. The secondary radiation from the filters having approximately the same wave length as the radiation transmitted by them, supplementary filters of aluminum were not used. The distance from the anticathode to the material was 40 cm. A variety of animal tumors were used, including mouse tumor No. 180, the Flexner-Jobling rat carcinoma and rat sarcoma No. 10. The voltages used were 30,000 and 100,000.

The experiments seem to point out that within practicable limits of wave lengths there is no difference in the lethal effect on tumor cells of long and short wave length radiation, provided equal quantities are employed.

J. D. CAMP, M.D.

Effect on Tumors of Radiation of Different Wave Lengths. Francis Carter Wood. *Am. Jour. Roentgenol. and Rad. Ther.*, Nov., 1924, p. 474.

Present-day electrotherapeutics.—In an address before the Section of Electrotherapeutics of the Royal Society of Medicine, the writer reviews the progress and status of roentgenology

in England, from the time of its discovery up to the present time. From a position of doubt and uncertainty roentgenology has reached a position of security. A properly equipped X-ray department is a vital necessity to the hospital of to-day, and the keen radiologist is now a not unimportant member of the hospital staff.

In referring to the evolution of the electrologist, the writer expresses his conviction that radiology and electrology, because of the high degree of specialization required for the practice of either specialty, are two branches of work which must be separated.

In reviewing the status of radiotherapy he objects to the terms "lethal" and "stimulating" doses. He concurs in Ewing's conclusions (1) that no uniform dose can ever be established, each case requiring individual consideration, (2) that results will not improve with increase in dosage, and (3) that deep therapy cannot safely proceed upon the theory of the direct killing of the cancer cell.

In conclusion, the opinion is expressed that the science of radiology as practised in England is slowly but surely progressing, and a tribute is paid to the American system of team-work which has yielded wonderful results, as exemplified by the work of the Mayo Clinic.

SOLOMON FINEMAN, M.D.

A Survey of Present-day Electrotherapeutics. Stanley Melville. *Lancet*, Jan. 10, 1925, p. 61.

HEREDOSYPHILITIC CRANIAL OSTEOPOROSIS¹

A PRELIMINARY REPORT ON A ROENTGEN-RAY STIGMA FOUND IN LATE CONGENITAL SYPHILIS

By KARL A. MENNINGER, M.D., TOPEKA, KANSAS

THE diagnostic criteria of late congenital syphilis are notoriously few and vague. It is a serious step medically and socially to make a positive diagnosis of congenital syphilis; it is equally serious to fail to make such a diagnosis. Yet it is one of the most difficult of clinical problems. Anything which adds to the definiteness of our diagnostic knowledge and technic has obvious intrinsic value.

It is logical that we should look to the roentgen rays for such additional aid in the diagnosis of congenital syphilis, particularly of the late forms. Bone lesions in congenital syphilis are well known to be frequent, moreover, it is generally agreed that the extent of the involvement as indicated by the roentgen ray is rarely paralleled by clinical symptoms (Skinner, Carman, *et al.*). It is possible that all cases of congenital syphilis may have more or less bone involvement, apropos of which Duenzelmann and Schmidt (1), in some sixty congenitally syphilitic children with positive Wassermanns, found that "the roentgen rays nearly always demonstrate osteochondritic and periostitic bone afflictions of the extremities, even when no signs pointed to the clinical changes of the bones" (quoted from Carman, 2). Hence, as Brown (3) has well said (as quoted by Carman), "The real use of roentgen rays in the general diagnosis of hereditary stigmas consists in the prominent part they should play in the general diagnostic overhauling, for instance, in the case of children who present the slightest evidence of such signs in the form of subjective symptoms which cannot be locally accounted for, e.g., photophobia and other ophthalmic manifestations, headache, snuffles, sore legs,

mental backwardness, skeletal asymmetries, etc." He believes that syphilis in its acquired form will never be a source of interest to the roentgenologist, but predicts that the hereditary types will supersede it. Definite diagnostic criteria will eventually thus be established.

It is the thesis of this paper that one such additional criterion is to be found in a certain osseous lesion revealed by roentgenograms of the skull. It is not maintained that this is a new sign or that it is pathognomonic or constant. I merely submit that there is this lesion, previously recognized but rarely referred to or utilized, yet frequently found in routine skull roentgenograms in neuropsychiatric cases which are definitely or probably heredosyphilitic. I have not proved that this lesion is never seen in non-syphilitic cases because I cannot prove that the few possibilities of that sort which I have seen may not have congenital syphilis, but I can show that these probabilities are infrequent.

The lesion referred to will be designated osteoporosis, but it is not to be confused with other destructive bone lesions occasionally described by the same term, seen in malignancy and acquired syphilis of the bone. It consists in a diffuse, irregular honey-combing of the bones of the cranial vault. It is apparently due to an irregular destruction or decalcification of the cortex of the bones so that the ridges of cancellous structure chiefly remain. Whether or not it is preceded in formation by a proliferative process cannot be determined from the lesion itself. It is apparently most frequently found in the frontal bone, but this is variable and all or any of the bones of the vault may be involved. Other bones of

¹Read before the Section on Nervous and Mental Diseases at the Seventy-fifth Annual Session of the American Medical Association, Chicago, June, 1924. Copyright 1924, by the American Medical Association. Printed by permission.

the body of the same case have never been observed to be involved.

Skinner (4), in 1911, described "a distinct type of syphilitic myelitis which produces an osteoporosis of the phalanges and of the calvarium." Later in the article he describes this "osteomyelitis syphilitica" as occasionally an extension of a gummatous periostitis but more frequently a primary medullary invasion. "The most startling demonstration is found in the plates of the skull. The flat bones of the cranium may take on a diffuse sclerosis with osteoplastic processes, but generally an osteoporotic change, with extending suppuration and eventually perforation, occurs. Small islands of bone may form which later may be discharged as sequestra with the formation of perforations in the skull plates. The roentgen-ray findings in an osteoporosis of the skull are conclusive; the thickening and plastic growth of the periosteum will be displayed by an increased shadow of this area; the porotic changes will be outlined by increased radiability; the islands of degenerated bone give the plate an appearance of irregular lace-work."

In an article ten years later, Skinner (5) elaborated on this observation. He emphasized the fact that syphilis in bone is usually a constructive osteoplastic process as opposed to the destructive nature of tuberculosis and malignancy. Osteoporosis luetica of the skull is an exception to this rule, and the only exception.² To this author probably belongs the credit for the first definite announcement of this finding.

In the article the author described a characteristic skull picture of cerebrospinal syphilis, to be differentiated of course from the lesion just described, and included here only for this contrast. "The skull tables are generally thickened; the diploic channels are prominent and the diploic lake of the parietal eminence is increased in dimensions; there are serrations like herring-

bones along the superior margins of the parietal bones in the lateral roentgen plate; and possibly the faint scalloped outlines of compressioni digitorum upon the inner tables."

Schüller (6) stated in 1912 that "luetic disease shows a well-known predilection for the face and cranial vault; it occurs less frequently in the region of the base of the cranium; however, in such instances the sphenoidal bone is most often involved. The formation of syphilitic granuloma originates from the periosteum or dura or from the mucous membrane or bone marrow.

"In all forms of syphilis, the cranium may be affected. Even in the early stages one may observe on the outer table of the frontal, parietal, and temporal bones, tophi between the bone and periosteum. The underlying bone shows interstitial atrophy, and the external table especially is traversed by numerous lacunæ and very rarely it is covered with periosteal aggregations, and the lacunar spaces of the diploe are greatly widened. As a rule the tophi are healed, whereby the previous interstitial atrophy of the bone undergoes sclerosis."

In the English edition of 1918, Schüller (7) writes, "Even in the early stages of the disease (lues) . . . , the bone lying underneath the periosteum appears osteoporotic, and the external table, especially, is perforated by numerous canals here and there, covered by periosteal deposits. The medullary spaces of the diploe are widened (rarefying osteitis).

"Congenital syphilis manifests itself on the skull in three ways, first, by ulcerative processes, similar to the acquired, second, through disturbance of growth in the sutures and fissures, and third, through hydrocephalus enlargement (Hochsinger, 8).

"Fournier (9) enumerated the following as dystrophic stigmata of hereditary lues on the skull: infantile vault, anomalies in ossification, broad nasal root, high palate, teeth anomalies.

"Shuttleworth (10) believed the develop-

²It is Skinner's belief that the exception constituted by osteoporosis to the general rule in regard to syphilitic bone lesions being osteoplastic (proliferative) is to be explained on the basis that even in these cases the lesion is first osteoplastic with secondary degeneration.

ment of the brain to be limited in hereditary syphilis, through an osteitis of the vault.

"In addition to the cases with congenital luetic hydrocephalus and those with luetic destruction of the facial bones spreading from the nasal cavity, we have repeatedly been able to point out positive roentgen findings on the cranium of syphilitics. Among them are found . . . four cases of superficial syphilitic osteoporosis."

In 1917, Knox (11) wrote: "In syphilitic disease of bone, the skull is the part most frequently involved and may show a curious worm-eaten appearance. In congenital syphilis, nodes, known as Parrot's nodes, form on or around the anterior fontanel. The newly formed bony tissue becomes sclerosed and dense, and deformity may then persist through life. Radiographically, a condition characterized by localized absorption of the osseous tissue of the cranium, leaving small areas where the bone is thinned or absent, are often met with."

In a roentgen-ray bulletin issued by the Surgeon-General, Pacini (12) reports: "Occasionally the deposition of lime salts in the periosteal tissues is irregular and unevenly distributed. The result is a lace-like appearance of the elevated periosteum. When it occurs, this lace-like periosteal reaction, serrated or tooth-like, is so typical of syphilis as to make it practically an infallible roentgen-ray sign of syphilis."

This refers to the ordinary lesions of tertiary acquired syphilis and not to osteoporosis as we see it in late hereditary syphilis, the latter being a medullary disease of a destructive sort, whereas this is a proliferative cortical process. There might, however, be some difficulty in making a distinctive differential description.

Most roentgenologists, however, and apparently all syphilologists have ignored the existence of this lesion. Carman (2), for example, in a comprehensive review of the roentgenology of syphilis with a bibliography of over eighty titles, makes no direct reference to osteoporosis. Hahn and Deyche-Pascha (13) describe all forms of

bone syphilis and mention osteoporosis of the tibia and fibula but not of the skull. They show roentgenograms of the skull in acquired syphilis but not in congenital syphilis. Rumpel (14) describes lesions of the legs but not of the skull. Zur Verth (15) does not agree with Rumpel, Hahn, Deyche-Pascha and others that bone atrophy is against a diagnosis of syphilis, but feels with Preiser that atrophy may be the result of syphilis and may be superimposed on the atrophy of rickets. But he also fails to discuss osteoporosis.

Stadler (16) discusses only the rarefaction seen in the arm and leg bones of late hereditary syphilis, illustrating his article with plates, but making no reference to the skull. Preiser (17), in a discussion of the same subject, notes particularly the atrophy seen in congenital syphilis. He gives three cases, all of congenital syphilis, one with multiple bone and joint signs, one with bilateral genu valgum and the third with confluent gumma in the fibula.

Friedrich (18) calls attention to the osteoporotic areas in acquired syphilis of the cranium, but he does not mention hereditary syphilis.

Loeffler (19) mentions the syphilitic osteochondritis and syphilitic periostitis ossificans, and states the general conditions and location of these conditions in the body, but he does not mention the occurrence in the skull.

Kuth (20) does not mention any changes in the skull in "early congenital bone lues," nor does Taylor (21) in an article on hereditary and acquired syphilis of bone. No mention is made by Coues (22) nor by Baetjer and Waters (23) of any changes in the skull in congenital syphilis, though other bone changes in this condition are mentioned briefly by the latter.

Tubby (24) classified the cranial signs of hereditary syphilis as: (1) partial or localized, and affecting a segment of cranium (take the form of bosses, frontal, parietal, or occipital, and either premature or delayed closure of the fontanels); (2) general affections of the cranium, including

osteoporosis of the skull. They are found in acquired syphilis as well as of the congenital (15) and Deychephaphy is not mentioned but feels the result of the disease is based on the fact that it fails to

rarefaction of late stages of the article due to the condition of the skull atrophy of the bones three months one with the disease with the head with

to the disease of syphilis of the skull mentioned

philitic osteoporosis conditions of the body, absence in

changes in the lues," "a nodule on the bone, nor by changes in though on are

signs of the frontal or front of the frontal, mature (2) including

increase or decrease of normal size of skull-cap. But Tubby makes no mention, either under congenital or acquired syphilis, of osteoporosis.

Finger (25) (in the section of his book dealing with the diagnosis of congenital syphilis) does not even mention the use of the roentgen ray.

Tilmann (26) describes periosteal gumma under "Diseases of the Skull," but does not mention osteoporosis or congenital syphilis.

Both Skinner (27) and Boorstein (28) refer to non-gummatus periostitis, particularly of the long bones, as an index of heredosyphilis tarda.

AUTHOR'S CASES

It is our practice to make routine skull roentgenograms on practically every neuro-psychiatric case. In 1919, Doctors Owen and Finney, Topeka, Kansas, reported osteoporosis in a case of an obscure nature that had been examined in various clinics (Case 70, Fig. 1). The chief symptoms were attacks of narcolepsy in which convulsions were absent during the first few attacks but eventually appeared after the fashion of the conventional epileptiform manifestations. Physical examination had already made us suspicious chiefly because of "a distinctly roughened booming aortic second sound over an area 10 cm. or more in diameter, transmitted into the cervical vessels and faintly even into the axilla." Roentgenographic examinations of the chest definitely confirmed the suspicion of an aortitis. The scapulae were scaphoid, a luetin test was positive, but the blood Wassermann negative. The spinal fluid Wassermann was reported faintly positive and the colloidal gold test was also reported faintly positive, the figures not given. Cerebrospinal fluid pressure was over twice the average.

He was put on arsphenamin and the attacks ceased entirely for over a year. At that time there was a recurrence and he took more treatment of another physician, who

reported immediate clinical response. This man's father refused a Wassermann at first, but it was secured by the second physician and was reported strongly positive.

The second case was seen six months later and has been previously reported by



Fig. 1 (Case 70). Male, aged 27, epileptic syndrome; narcolepsy, aortitis; Babinski positive, luetin test and B. S. W. negative. Spinal fluid Wassermann and Lange weakly plus. Father's B. S. W. positive, mother's negative. Best example.

me (29). It (Case 153) was also a case of epileptiform manifestations in a 17-year-old lad who had been precocious in his studies until two years previously, when typical *grand mal* began. He showed a number of suggestive stigmas, including the stippling of the retina of the *salz-und-pfeffer* variety, markedly scaphoid scapulae, Stiller's habitus asthenia universalis congenita, exaggerated tendon reflexes and a relative lymphocytosis. He had a negative blood Wassermann, an anticomplementary spinal fluid Wassermann and a Lange test of 0124443200. There was a typical gumma on his ankle (Fig. 2). The diagnosis was first suspected when the roentgenologist reported osteoporosis, "suggesting hereditary syphilis."

A puzzling circumstance in this case which we have observed several times in the face of indisputable proof of hereditary syphilis was that both parents had negative Wassermann reactions. This is explicable on a variety of bases, however; it is uni-

versally acknowledged that latent syphilis may give a negative Wassermann for years and both before and afterward a positive reaction.

This lad improved very remarkably under arsphenamin. The gumma began to



Fig. 2 (Case 153). Male, aged 17, epileptic syndrome; extensive osteoporosis; one stillbirth; one sibling died in infancy; one convulsive; one headache. Stippled retinae, reflexes plus, scaphoid scapulae. B. S. W. once doubtful. Spinal fluid Wassermann negative, Lange positive. Ankle gumma. Parents' B. S. W. negative.

heal at once and was soon gone. The seizures decreased in frequency and severity. He gained weight and improved markedly in his general mental condition.

Such cases as these two, in which the diagnosis was largely made or at least confirmed by the roentgen-ray findings, strongly interested us in osteoporosis as an index of congenital syphilis. Since then thirty-five cases have been studied in which osteoporosis was reported by Drs. Owen and Finney. (Those roentgenographed in our own clinic were excluded to standardize the interpretations on the series.) In the great majority of them there are other strong reasons for suspecting congenital syphilis. In six of the cases there is no other evidence, and in nine the evidence is not conclusive. In the remaining nineteen we feel that there is little doubt as to the existence of syphilis. Abstracts of some of these cases will be given.



Fig. 3 (Case 489). Boy, aged 19; narcolepsy and convulsions; osteoporosis typical. B. S. W. once doubtful, father ibid. Lange positive, also pupils, etc. Poor plate.

EPILEPTIC SYNDROME

Case 489 (Fig. 3) was a boy of 19 of excellent physique whose parents were subject to headaches and whose father had a doubtful Wassermann. The boy himself had a very curious form of convulsive attack in which he did not lose consciousness but which otherwise resembled the conventional *grand mal*. He, like the first case reported, also had attacks of narcolepsy. There were a number of evidences of neuropathology; the right side of the palate was less active than the left, the uvula tipped to the left, the Romberg was slightly positive, there was a marked tremor of the hands and the right pupil was larger than the left and reacted to light less promptly and fully than the left. His blood Wassermann was once weakly positive, although several times negative, and there was a relative lymphocytosis; the spinal fluid was examined repeatedly and always showed an excess of globulin and a positive gold test, with a negative Wassermann. The patient made a marked improvement under silver arsphenamin.

Case 960 was a little girl of 11 whose father had died rather unexpectedly after an operation and whose mother's cup of woe was filled the fuller by the advent of

typical *grand* and *petit mal* in this child. The patient had previously had migraine. (The mother and her sister also had migraine.) The child had a negative blood Wassermann but a strongly positive spinal fluid Wassermann and Lange. She had much scattered stippling of pepper pigment in the retinæ, unequal tendon reflexes, a restriction of the pupillary light reaction to about one-fourth the normal, a dome forehead and a relative lymphocytosis. The mother had a negative blood Wassermann but had had two miscarriages and one "blue" baby. The osteoporosis in her case was reported by the roentgenologists as "moderate, generalized."

Case 625 was a married woman of 19 who was first seen in an attack of status epilepticus. She was the only child of parents who had had one stillborn child; her father was generally regarded as having had hereditary syphilis and an oculist who examined his eyes at our request gave that as the probable diagnosis. His Wassermann and that of his wife were negative, however, as was also that of the patient. The patient had Argyll Robertson pupils and absent knee-jerks. She did not improve under neo-arsphenamin but did improve markedly under psychotherapy, and a psychanalytic study of the dynamic mental factors in the case is being prepared for presentation elsewhere. The osteoporosis in her skull was reported as slight.

Case 981 was a girl of 15 who had also presented an epileptic syndrome. Her mother had had two miscarriages, her sister had spasms. She herself had pigmented retinæ, high arched palate, irregular, malformed teeth, not conclusively Hutchinsonian, unequal, dilated pupils, and a deviation of the tongue to one side. She showed also some minor evidences of endocrinopathy, an anemia and a relative lymphocytosis. The spinal fluid Wassermann was weakly positive and the Lange test read 0012554100. The osteoporosis in her case extended from the frontal bones back to the parietal bones.

Case 442 was a boy of 19 whose father was nervous and subject to headaches and who was brought with a history of having as many as ten convulsions daily in addition to *petit mal*, headache, weakness and



Fig. 4 (Case 442). Male, aged 19; epileptic syndrome. Bulging forehead, high palate, large lymph nodes, nerve deafness, right. B. S. W. and spinal fluid negative. Many convulsions. Excellent example.

dizziness. He had definite nerve deafness in one ear, hypotonia of wrists and fingers, marked tremor, hyperactive tendon reflexes, narrow, bulging forehead, high arched palate and numerous enlarged lymph nodes and an osteoporosis of the inner table (Fig. 4). This is not a conclusive case; it is one of the least convincing in the series, but it is included as representative of that group. It was impossible to make an examination of the parents, and follow-up inquiries have been unsatisfactory.

Case 602 was also brought for examination because of epileptiform attacks. The patient was seen only for a few hours and disappeared from view entirely, but the data are more than suggestive. The mother had had at least one miscarriage. The patient himself had typical Hutchinsonian teeth, a high, narrow palate, dotted with hemorrhagic petechiae. Bone conduction of sound in both ears was reduced 20 per cent.

A brother who accompanied him had a strabismus and a cataract. His Wassermann was negative. Osteoporosis was marked.

HYPOPHRENIC SYNDROME

Case 964 was a boy of 13 who at first sight seemed to be a simple case of feeble-mindedness. His reflexes were hyperactive, his tongue deviated to the left, there was a bilateral Babinski and Oppenheim, and he had scaphoid scapulae. His pupils were approximately normal, however, although his mother's pupils were suggestive.

The outcome of the case was quite dramatic. The roentgenologist had reported that all cranial bones showed some osteoporosis (Fig. 5), and our faith in the dependability of the sign was considerably shaken because the family was one in which syphilis seemed very unlikely. The patient's Wassermann was reported 4 plus, however, as was also his mother's and his brother's. His father had a 1 plus, which we have interpreted as negative. This was one of the cases which stimulated our admiration for the value of the sign and our interest in it.

PSYCHONEUROTIC CASES; NEURASTHENIC SYNDROMES, PLUS

It will be recalled that no less a psychogeneticist than Sigmund Freud declared that half of his severe psychoneurotics were the children of syphilitic parents to his definite knowledge. Every neuropsychiatrist sees patients for whom the descriptive diagnosis must be anxiety neurosis, neurasthenia, or a similar category in which the evidences of congenital syphilis are strong if not conclusive. These patients usually have negative Wassermanns, probably because by the time they reach the psychiatrist the conspicuous organic and serologic effects of syphilis have been covered up and only the functional adaptation failures remain for inspection. This is the more plausible in view of the increasingly prevalent belief that there are several strains of

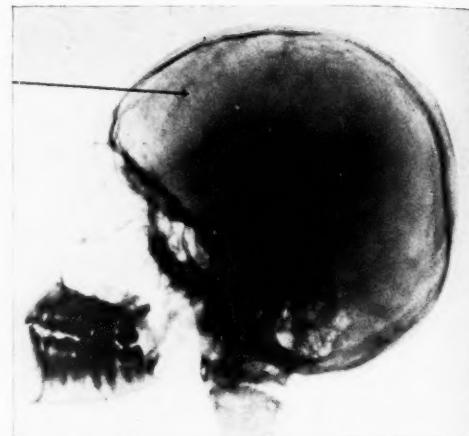


Fig. 5 (Case 964). Boy, aged 13, feeble-minded. B. S. W. positive, also mother's and brother's. Bilateral Babinski. Pupils and spinal fluid negative. Osteoporosis generalized. Shows poorly.

the syphilitic organism, one or more of which have a peculiar affinity for brain tissue.

The following are cases of considerable symptomatic similarity, *i.e.*, typical psychoneurotic syndromes, and all of them showed osteoporosis, and some of them showed other definite evidences of congenital syphilis.

Case 973 was a girl of 22 who had run from doctor to doctor complaining of weakness, nervousness, headaches, mild depression and pain and tenderness over the bladder. Thorough examination (including cystoscopy, etc.) revealed no structural pathology to explain any of these symptoms. She had some slight pupillary pathology, scaphoid scapulae, hyperactive tendon reflexes and a tremor of fingers and eyelids. These, of course, were convincing of nothing. She had osteoporosis of the frontal bone; her Wassermann gave a 2 plus reaction with a cholesterinized antigen (which would ordinarily be interpreted as negative). Her spinal fluid gave a strongly positive Wassermann and a positive Lange (0135555222). Her father had a weakly positive Wassermann at one testing, at other times negative. Intravenous arsenic did the



Fig. 6 (Case 1119). Male, aged 31, neurasthenic syndrome. Marked osteoporosis. B. S. W. doubtful, father's B. S. W. ibid. Lymphadenopathy. Pupils irregular and slow. K. K. plus and unequal. Good example.

girl considerable apparent good, but it is a question how much of this was suggestion and how much spirocheticidal action.

Case 1119 was a man of 31 who was brought by his father for a typical neurasthenic syndrome which had followed influenza several years previously. Physically he had an enlarged heart, numerous palpable lymph nodes, scaphoid scapulae, irregular, sluggish pupils which reacted through about one-fourth the normal distance, slovenly articulation, hyperactive and unequal tendon reflexes. His Wassermann was weakly positive, as was also his father's. His spinal fluid showed a slight increase in globulin, a Lange test of 1121100000 and a negative Wassermann. Osteoporosis was marked (Fig. 6).

Case 1058 was a girl of 16 with typical hysteria major. Her aunt had "nervous attacks," her cousin was insane. The father was described as "high tempered" and his treatment of the girl's hysteria was to beat her. Her pupils were unequal and her tendon reflexes hyperactive; her Was-

sermann negative. Osteoporosis was reported as "considerable."

No. 1105 was a college student of 21 who came in complaining of tremulousness, irritability, and other mental symptoms of this sort. He was found to have an enlarged heart, a systolic blood pressure of 145, conspicuously prominent frontal bosses, a high relative lymphocytosis, unequal, irregular pupils and osteoporosis of the frontal bones. His mother was a chronic invalid, his uncle died of paresis, and an aunt is extremely nervous.

In striking contrast to the doubtfulness of some of the previous cases and yet presenting very similar symptoms, was that of a case of a prominent professional woman, 22 years old, who came in for a routine examination because of nervousness, exhaustion, depression, rapid heart and pain in the side. Her pupils were slightly irregular but were equal and responded normally to light. There was no other definitely positive pathology, although there was a questionable Babinski and a slight tremor of the eyelids, lips and hands. There was a slight generalized osteoporosis of the inner table. Her blood Wassermann was reported strongly positive. She informed her mother of this and her mother related that the patient's father, now dead, had confessed to having had syphilis before his marriage, but thought that he had been cured of it and they thought it never necessary to mention the matter further.

How often a similar infection occurs in which the husband does not tell even the wife, must be only speculative. It must certainly be more frequent than such cases as this in which the facts are finally known to all parties. It is a puzzling question, for example, to decide whether this girl's sister, who is subject to severe headaches, is similarly infected with congenital syphilis, and a still more difficult theoretical question to decide how much the illness of both daughters depends on the fact that the mother was nervous and excitable and the grandfather insane. The difficulties of the matter are strongly emphasized by the fact



Fig. 7 (Case 955). Male, aged 34, paranoid psychosis. Osteoporosis slight. Headaches marked. Pupils fixed. Reflexes plus. B. S. W. once doubtful. Oppenheim plus. Note very thick skull. Not typical—very extensive and shallow.



Fig. 8 (Case 836). Girl, aged 20, manic-depressive psychosis, manic phase. Osteoporosis only evidence of syphilis. Fairly typical. Case otherwise negative.

that the mother had a negative Wassermann. There is nothing to prove that this girl may not have acquired syphilis, making the history of her father's syphilis only a coincidence, but her symptoms were not those of acquired syphilis and the assumption of the coincidence hypothesis would seem to be straining at a gnat and swallowing a camel.

PSYCHOTIC CASES

Case 955 was a man of 34 with a mild paranoid psychosis, having contracted, irregular, fixed pupils. The right side of the palate drooped, the tongue protruded to the right with a tremor, reflexes were hyperactive and there was a positive Oppenheim on the left. He had a doubtful Wassermann and slight osteoporosis (Fig. 7). His father was a Western pioneer, irritable, nervous and eccentric.

Case 836 was a typical case of manic-depressive psychosis in the manic phase, a school teacher of 20. Her mother had had convulsions in infancy, but aside from this there was no physical, hereditary or serologic evidence of syphilis except a "marked osteoporosis" (Fig. 8). This is one of the cases contra-indicating the pathognomonicity of the sign.

MISCELLANEOUS CASES

Some of the most convincing cases did not fall in either the epileptiform or psychotic-psychoneurotic groups.

Case 662 came in for examination at the age of 44 with classical symptoms of angina pectoris. Her pupils excited some suspicion, and a roentgenogram of the head was made which showed a marked osteoporosis. Her Wassermann was reported definitely positive (3 plus). Her husband's Wassermann was negative (but, of course, the infection may still have been primary with him).

Case 896 was a woman of 30 who came in complaining of severe headaches and lassitude. She had had one miscarriage and a feeble-minded son. She had fixed, irregular, unequal pupils and a slight facial paresis. Her Wassermann was slightly positive. There was a moderate amount of osteoporosis in the frontal and temporal bones. The husband stated that her father had told him of having acquired syphilis in his youth. The value of the case is almost entirely canceled, however, by the fact that the husband also had a positive Wassermann and the possibility of his wife's syphilis having been acquired from him is too great to be disregarded.

Case 882 was a girl of 14 with a typical history of epidemic encephalitis followed



Fig. 9 (Case 882). Girl, aged 14, encephalitis, epidemic. Much neuropathology, probably encephalitic, rather than neurosyphilitic, but marked osteoporosis discovered and mother's B. S. W. strongly positive. Shows poorly.

by very curious respiratory sequelæ. Examination showed numerous encephalitic symptoms, such as thickening and slurring of the speech, ptosis of the eyelids, irregular pupils reacting slightly to light, drooling, tongue deviation, unequal and sluggish knee-jerks, one absent ankle-jerk, bilateral Oppenheim, reduction in vibratory and pain sensation. A considerable osteoporosis (Fig. 9) of the frontal bones was discovered in the course of a routine roentgen-ray examination. Her Wassermann was negative but her mother's was strongly positive.

Case 739 was a boy of 19 who fell from a truck and sustained a skull fracture followed by a week of unconsciousness and delirium. It was found that he had stippled retinæ, bilateral deafness, unequal tendon reflexes and had been subject to periodic headaches during which he was bedridden and delirious. His father had also had these headaches, as had one of the father's sisters; two of the patient's siblings had these headaches and another had had convulsions in childhood. The father had had two strokes of paralysis. Routine roentgenography to discover the site of the fracture

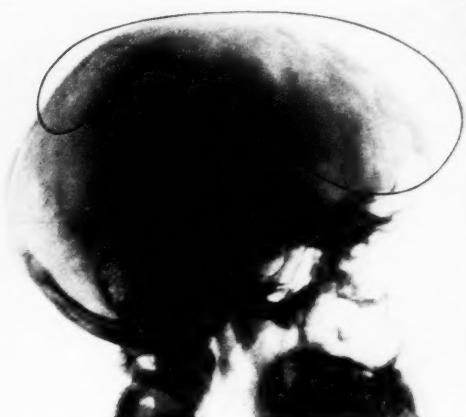


Fig. 10 (Case 739). Male, aged 19. Skull fracture, B. S. W. plus. Stippled retinæ; deaf, migrainous, unequal reflexes. Father apoplectic. Siblings (three) convulsions and migraine. Diffuse; generalized.

also revealed much osteoporosis (Fig. 10), and the Wassermann was weakly positive.

Other syndromes represented were migraine and dyspituitarism. All the syndromes in which the lesion has been found could be listed under one of these few various categories named (epileptiform, hypophrenic, neurasthenic, psychotic, migrainous, dyspituitary) which are strikingly limited in variety, all of them indicating the probability of structural brain or endocrine gland injury.

The accompanying tables summarize the data in a representative group of these cases. For our purposes it is valuable although not necessary to demonstrate the probability of syphilis in the parents, since there are few criteria of congenital syphilis as such, particularly in the late and abortive forms, in which we believe this sign to be valuable. Consequently we have been on the lookout for evidence of syphilis in the parents, evidence of congenital syphilis in the siblings, evidence of syphilis as such in the patient and evidence of hereditary stigmas of syphilis in the patient. It is rarely possible to have all of these indications definitely established in a single case.

One of the most confusing items is the matter of the Wassermann test. There is so much difference of opinion among serolo-

TABLE 1.—EPILEPTIC SYNDROME GROUP^a

	Case 70	Case 153	Case 489	Case 960	Case 625	Case 981	Case 602	Case 442
Parents:								
History of syphilis.....	—	0	0	?	+	0	—	—
Miscarriages	0	+	—	+	+	+	+	—
Physical and neurologic	—	?	0	0	+	0	—	?
Serology	+	0	?	0	0	0	—	—
Siblings affected	0	+	1	0	1	+	+	0
Patient:								
Physical	+	+	?	?	0	?	+	?
Neurologic	?	+	?	?	+	?	0	0
Serologic	?	?	?	+	?	?	0	0
Therapeutic	+	+	+	?	0	+	—	—
Summary:								
F. H.	+	?	?	?	+	?	?	0
Patient	+	+	+	+	?	?	+	?

TABLE 2.—PSYCHONEUROTIC SYNDROME GROUP

	Case C	Case 973	Case 298	Case 1119	Case 1026	Case 1105	Case 1058	Case 585
Parents:								
History of syphilis.....	+	0	?	—	—	?	—	—
Miscarriages	0	0	—	0	—	0	0	—
Physical and neurologic	?	0	—	?	—	?	—	—
Serology	—	?	—	?	—	—	+	—
Siblings affected	+	0	+	0	0	0	0	+
Patient:								
Physical	?	0	?	?	?	+	0	?
Neurologic	0	?	0	?	?	?	0	0
Serologic	+	+	0	?	?	0	0	0
Therapeutic	+	?	+	—	—	—	—	—
Summary:								
F. H.	+	?	0	?	0	0	+	?
Patient	+	+	0	?	?	?	0	?

TABLE 3.—MISCELLANEOUS GROUP

	Case 964	Case 806	Case 882	Case 739	Case 759	Case 955	Case 838	Case 863
Parents:								
History of syphilis.....	0	+	—	—	?	—	—	—
Miscarriages	0	—	0	—	+	—	—	—
Physical and neurologic	+	—	0	?	—	?	—	—
Serology	+	—	+	—	—	0	—	—
Siblings affected	+	—	0	+	+	0	0	0
Patient:								
Physical	?	+	0	+	+	0	0	+
Neurologic	?	+	+	+	+	+	?	?
Serologic	+	?	0	+	?	?	?	0
Therapeutic	+	+	—	—	+	—	—	—
Summary:								
F. H.	+	+	+	0	?	0	0	0
Patient	+	+	+	+	+	?	?	?

^a In the tables, 0 means absent or negative; — means not done or ascertained; ? means dubious or weakly positive; + means definitely positive; 1 means only child.

gists and syphilologists as to the meaning of the Wassermann test in hereditary syphilis that it is difficult to know what attitude to take. It is certain that some unquestionable cases of congenital syphilis have negative Wassermanns, and it is apparently true that some cases of congenital syphilis have positive Wassermanns and no other indications whatever. Consequently, when the Wassermann is positive we have counted it a positive indication; when negative we have disregarded it. We have repeatedly established the fact that the parents of syphilitic children may themselves have negative Wassermanns at the time the examination becomes necessary. Nevertheless we confess to a feeling of misgiving when the Wassermanns of the patient and both parents and perhaps some of the siblings are all returned negative. We are not sure that we are justified in accepting even this as positive proof of the non-existence of syphilis, but we have felt that such cases were certainly not of value in the consideration of the osteoporotic lesion now under consideration.

Osteoporosis is certainly not always present in congenital syphilis, nor in late heredosyphilis, nor even in late heredoneurosyphilis. We have found no evidences of it in a number of such cases of undoubted authenticity. It is probably not pathognomonic in that the presumption in about 20 per cent of our cases is against the existence of syphilis in any form. It is nevertheless absent from the great majority of skulls and deserves to be recognized as bone pathology. Our experience would indicate that it is often and usually associated with late heredoneurosyphilis. Whether it represents (1) product of the syphilitic process *per se*, (2) a dystrophic deficiency resulting from germ plasm injury wrought by syphilis (or some other toxic source) or (3) merely a stigma of somatic degeneration such as scaphoid scapulae, I do not know. I submit merely that it is a definite bone lesion frequently found in congenital syphilis and particularly congenital syphilis of the nervous system.

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RADIO-ACTIVE SUBSTANCES AND THEIR THERAPEUTIC USES AND APPLICATIONS

RADIUM THERAPY OF CARCINOMA OF THE PROSTATE

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MALIGNANCY of the prostate in some respects offers more difficulties to the physician who attempts to cope with it than does any other growth of this character elsewhere located. There are several reasons for this. Obviously, its sequestered situation makes it less easy of access than neoplasms nearer the surface, but aside from this, several other factors combine to render the control of the malignancy in this gland an especially difficult problem. Very often the disease will be far advanced before there is the slightest indication of its presence, and even when symptoms do appear they are those common to a number of disturbances in the urogenital tract, and not sufficiently characteristic of prostatic cancer to immediately suggest the possible existence of that lesion. Thus much valuable time is likely to be lost, and when the diagnosis is finally made the patient is all too frequently beyond the aid of any treatment.

Early metastasis is especially characteristic of prostatic neoplasms. Extension to the bladder is very common, because, as one of wide experience with these growths has recently pointed out, the gland lying between the dense fascia of Denonvillier and the firm, though somewhat more yielding, fascia forming the base of the bladder, offers the invading growth practically no room for expansion except by metastasis. Moreover, the contraction of the vesical sphincter after each micturition exerts a frequently recurring pressure upon the growth that would seem especially likely to induce early invasion of the bladder, and very probably contributes not a little to the encouragement of early metastasis.

If it is purposed to employ radium treatment, measures should always be taken to ascertain whether or not metastasis has occurred. Glandular involvement is common-

ly detected easily, but as cancer of the prostate is likely to extend to the lumbo-sacral region and to the chest, only thorough examination by roentgenography will serve to give definite information as to whether or not the malignancy is still localized in the prostatic region. If secondary foci are found it should be realized that treatment by radium offers little beyond palliation. The pain in the back and extremities which is so often a distressing feature of cases where the sacral region is involved, may frequently be much lessened or even entirely abolished following radium applications. More than 60 per cent of the patients reported by Deming as suffering from pain in the back were entirely relieved of this symptom after radium treatment. Bumpus, however, takes quite an opposite view of the advantages of radium under such conditions. He attributes pain in the lower back with radiation down the outside of the thigh or around the hips, to involvement of the lymph nodes of the sacral promontory and aorta which drain the prostate, and the attacks of sciatica of which these patients so frequently complain to periprostatic extension of the malignancy. He states emphatically that irritation induced by nerve pressure is uninfluenced by radium treatment, even when the tumor in the prostatic area may be considerably reduced in extent.

Another contra-indication to the use of radium in carcinoma of the prostate is poor renal function, such as is very frequently induced by the retention secondary to prostatic hypertrophy. Even when it is most carefully applied, the absorption of destroyed tissue inevitably following radium treatment, puts an added strain upon the excretory organs, and if the kidneys are already somewhat crippled, the results may very easily be fatal. By the employment

of widely distributed, individually small, units of dosage, extensive necrosis can be largely avoided and the amount of toxic products which must be eliminated materially reduced, but the consideration still looms large in treating malignancy so situated that its very existence has already reduced the functional capacity of the kidneys.

DIFFERENT METHODS OF APPLICATION

Having ascertained that the particular patient under consideration is a fit subject for radium treatment, the next consideration will be the most satisfactory way in which the treatment can be applied. For more than a decade the use of radium in cancer of the prostate has been a subject of great interest to all those concerned with this therapy, but the numerous variations in the methods employed, and the number of changes which are continually being made, indicate clearly that the perfectly satisfactory mode of application has not yet been found. The method first employed consisted simply in placing a tube of radium element, usually screened with silver, in a catheter which was introduced into the urethra, so as to bring the radium in contact with as much of the prostatic tissue as could be reached by this route. Later a cystoscope was used to direct the placing of the radium tube more accurately, but with the gradual improvement of instruments it became possible to adjust the radium applicator entirely by manipulation, both by the urethral and rectal routes, and, by passing the radium container all the way into the bladder, it became possible to bring the rays to bear upon the prostate from three different angles. One hundred milligrams of radium applied for an hour in various locations which could be reached through the rectum, urethra and bladder, was the customary dosage.

A method which gave fairly satisfactory service at the Mayo Clinic consisted in the use of a No. 10 soft rubber rectal bougie marked off in centimeters, with a window

cut in the side to hold the radium tubes. When first inserted the bougie is so placed that the window comes within the bladder area of the rectal mucosa. Each succeeding hour the bougie is withdrawn one centimeter, so that a new section of rectal mucosa is exposed. For urethral applications the radium container is a rubber-covered brass tube, attached to which is a handle made of soft solder, which is so flexible as to bend readily to meet any curve in the prostatic urethra. This applicator is gradually withdrawn at regular intervals in the same manner as the rectal appliance. In the earlier work at this clinic the amount of radiation applied in the rectum averaged 1,482 milligram hours, and that in the urethra 217 milligram hours. It was found, however, that the rectal dosage was much higher than was either necessary or desirable, and the proctitis which frequently resulted led to the abandonment of this form of radium treatment.

At the Memorial Hospital some cases have been treated by making use of a urethroscope and inserting through its sheath tubes of radium emanation to which linen threads are attached. These tubes are about 2 cm. in length and are screened with one millimeter of rubber and 0.6 millimeter of silver. When the tubes are completely within the bladder the urethroscope is removed, the tubes being thereafter gradually withdrawn through the urethra by means of the attached threads. This method was serviceable in those cases in which the prostatic malignancy had extended into the urethra. The largest dosage employed was 200 milli-curie hours.

"NEEDLE" METHOD

The use of the screened tube or other similar container has now been largely abandoned in favor of the needle applicator, designed by Barringer of the Memorial Hospital. These instruments are now employed at Johns Hopkins, the Mayo Clinic and most other centers where radium treatment of prostatic carcinoma has received

special attention. The needle customarily employed is of steel, averaging from 10 to 15 cm. in length, the last three centimeters serving as the radium container. When this method first came into use much larger doses were employed than the accumulation of experience has since shown to be necessary. Needles containing as much as 12.5 milligrams of radium element were inserted and allowed to remain in one spot for from twelve to twenty-four hours, with resultant necrosis and sloughing which was especially undesirable in dealing with cancer of the prostate. It was soon found that much better results followed the location of a 12.5 mg. needle at a given point for only four or five hours, withdrawing it in the same manner as described for the tubes. By using several needles inserted at different angles and withdrawing them six times in twenty-four hours it became possible to irradiate practically all the tissue of the prostate while no one area was overexposed. At the Mayo Clinic four needles were used, each being withdrawn 12 mm. at three different times, which in two treatments meant the irradiation of twenty-four separate areas, which all together received a dosage of approximately 1,500 milligram hours of radiation without any serious irritation or burning, and with practically no toxic reaction.

Another method of application by needles consists of inserting two, each containing twelve and a half milligrams of radium element, through the skin of the perineum under local anesthesia, the operator meanwhile keeping his unprotected finger in the rectum to guide the point of the needle as it advances. This method was used by Young in conjunction with applications in the bladder, urethra and rectum, as by this means the central tissues of the prostatic lobes which the radiations from the tubes could not reach, were exposed to the action of the rays. A complete therapeutic series consisted of an hourly treatment of 100 milligrams of radium, applied twenty times through the rectum, ten times through the urethra and ten times through the trigone,

while there were, in addition, eight applications of twelve and a half milligrams through the perineum by means of needles.

Barringer himself uses 50 to 100 millieuries of radium emanation in a steel needle which he inserts into one of the prostatic lobes through the perineum, using novocaine anesthesia. When the needle has remained in place for the desired length of time it is withdrawn from the lobe where it was first inserted, but not pulled all the way out through the perineum, and again inserted, this time into the second lobe. If the malignant tumor is approximately 2 cm. in diameter it can safely receive an initial dose of from three to four hundred millicurie hours. The dose is repeated after an interval of two or three months, a somewhat smaller quantity of radium emanation being usually employed for the second treatment.

Seminal Vesicles.—The needle method has proved very effective when the malignant process has extended to the seminal vesicles. This may be done through the rectum if sufficient care is used to thoroughly cleanse the canal before making the insertion. Under the guidance of a finger inserted into the rectum a small cannula is first advanced as far as the area where the vesicles approximate the rectal wall; the needle carrying from 50 to 100 millicuries of radium emanation is passed through the cannula and carried through the wall directly into the vesicle.

The Radium Emanation "Seed" Method has now, however, largely superseded all others, in that it includes all the advantages offered by any of the methods just described and does away with a number of their drawbacks, besides combining merits which are peculiarly its own. Chief among these last is the fact that the reduction in the amount of necrosis induced by the radium emanation "seed" method does away with the extra strain upon already damaged kidneys, which is so peculiarly disadvantageous in dealing with carcinoma of the prostate. This alone removes one of the greatest drawbacks to the successful em-

ployment of radium therapy in this condition.

The implantation of radium emanation tubes within the prostate can best be accomplished by the aid of the author's "loading slot" radium seed implanter, an improved instrument for handling capillary tubes of radium emanation, which was described something over a year ago. Used in conjunction with Young's urethroscope or the McCarthy instrument, the entire implantation can be carried out under constant visible observation, and the same puncture channel may be utilized for successive implantations, causing less trauma and taking much less time than any of the older methods.

Technic of Perineal Implantation.—With the patient in the lithotomy position and under proper aseptic precautions, a spot upon the median raphe about an inch and a half below the anus is infiltrated with 0.5 per cent novocaine solution, care being taken to anesthetize not only the skin, but the underlying tissues. When this area has had time to become insensitive the needle is passed through the tissues of the perineum into the prostate itself, and from fifteen to twenty cubic centimeters of the novocaine solution injected into the prostate itself as well as the tissues immediately around it. Anesthesia being established, a trocar can be passed through the midline of the perineum through which the implanter carrying radium emanation "seeds" is inserted and the tubes placed in any desired position, merely by slightly shifting the angle of the trocar, up or down, backward or forward, as the operator desires. The entire gland can be thoroughly covered in this way, the tubes—which should contain no more than 0.5 millicurie, while 0.3 is even better—being so arranged as to lie about a centimeter apart all over the gland. The operator's left index finger in the rectum serves as a guide, both for the original insertion of the trocar and the subsequent placing of the radium emanation "seeds" and this may sometimes be advantageously reinforced by a sound in the urethra, es-

pecially in those cases where it is desired to make implantations as high up as the trigone. It is possible to implant not only the prostate gland itself, but the seminal vesicles, the trigone or even the anterior commissure without withdrawing the trocar. This method has proved very successful, especially in those cases where urinary symptoms were not very distressing at the time the patient came under treatment. Though it is still of too recent conception to allow the making of dogmatic statements in regard to the permanency of its curative powers, it is notable that patients now in the third year since their first treatments are apparently well and able to go about their daily work.

Deep X-ray Therapy has proved extremely efficacious in connection with radium emanation implantations in those cases where there was some evidence of metastasis, and the urinary symptoms, such as dysuria, frequency and a large quantity of residual urine, were markedly in evidence. A thorough X-raying previous to taking any measures for the relief of the obstruction will greatly lessen the danger of dissemination of the cancer cells by any surgical procedure which may later on prove necessary. Should the radium emanation implantation not serve to reduce the symptoms of obstruction satisfactorily, and surgical removal of the hypertrophied tissue become imperative, the preliminary raying and radiation by implantation of radium emanation tubes will measurably lessen the danger, especially in the case of very old or extremely feeble subjects.

Implantation Through an Incision which gives a thorough exposure of the area of malignancy in the prostate has decidedly evident advantages over the method of perineal implantation just described. As it can be done under local or sacral anesthesia it gives little more concern to the patient, and the operator being thus able to obtain direct vision of the entire area to be implanted, can do his work with greater accuracy and dispatch than by any other route.

Advantages of the Use of Radium Emanation.—Besides the advantages already

noted, the use of radium emanation in capillary tubes instead of the employment of the element itself makes it possible for us to gauge our dosage with greater accuracy, for we can exactly measure the lessening intensity of the radiation, and can safely permit the "seeds" to remain in place without danger of producing necrosis, as we know that the intensity of the radiations from radium emanation thus applied decreases at a regular and well-comprehended ratio. It even makes possible the administration of "out-patient" treatment, though this is not usually to be recommended. In general, all prostatic carcinoma patients should be hospitalized. Success of any therapy with these patients is quite as much a matter of careful nursing and constant watchfulness over the general systemic condition, as of the particular form of treatment employed.

Radium in Conjunction with Surgery.—Where it has been necessary to relieve retention by suprapubic drainage, or to do a partial suprapubic prostatectomy or what is known as the Young punch operation, the excised tissue is not infrequently found to be malignant. In those cases, post-operative implantation of radium emanation "seeds" into what remain of the prostatic tissues and their surroundings, combined with deep X-ray applications to the tissues of the pelvis, will often serve to prevent metastasis or recurrence at the site of operation.

Pre-operative Use of Radium has been less frequently employed, but, as we have already noted, is regarded as lessening the dangers of dissemination of the malignant cells. In two cases reported some time ago

Foreign bodies in the bronchi.—This is a report of two cases of non-opaque foreign body in the lungs. The work done by Manges of Philadelphia in the roentgen-ray diagnosis of these non-opaque foreign bodies is of the greatest value. In a typical case the X-ray films show three characteristic signs: (1) Increased transparency over the entire affected side, caused by obstructive emphysema. The foreign body acts as a ball-valve, admitting air on in-

by Deming, four thousand milligram hours was given two weeks before perineal prostatectomy. Both specimens removed at operation showed hypertrophied tissue which had been infiltrated by malignant cells, but when the capsule was stripped off it proved to be entirely free from malignant invasion; the cancer had evidently been absorbed within the capsule. The only assumption in these cases seems to be that the massive radiation of two weeks previous had caused its destruction. In other cases reported at this same time a one hundred milligram capsule was inserted into the operative wound and permitted to remain from five to eight hours, and the author states that the wounds healed as well as those where no malignancy had been present, and no fistulae were ever seen. The implantation of radium emanation tubes will be found, however, to constitute a much safer and more accurate post-operative treatment, thoroughly eradicating any cancerous tissues which may have been left behind, but at the same time avoiding the production of necrosis, with its attendant strain upon the already overtaxed kidneys.

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spiration but not allowing egress of air on expiration. (2) Depression of the diaphragm on the affected side. (3) Displacement of the heart and mediastinal structures away from the affected side.

SOLOMON FINEMAN, M.D.

Two Cases of Vegetable Foreign Body in the Bronchus. R. P. Mathers. *Jour. of Laryngol. and Otol.*, Jan., 1925, p. 24.

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A PORTABLE APPARATUS FOR MEASURING X-RAYS¹

By ROY KEGERREIS, ANN ARBOR, MICHIGAN

RADIATION therapy is very much in need of practical methods for comparing the output of different X-ray machines. It is essential that every installation be checked up occasionally so that its users may have assurance that the output is constant as well as know how it compares with the installations of other workers.

Quality and quantity are the things about which a testing apparatus for X-rays should give data, since they are used for the comparison of different installations. Only a method which measures the terminal, or end, product can be employed to give unimpeachable data for determining such factors.

Depth dose for specified conditions of aperture and distance, when once worked out for some one effective wave length, always remains the same for that equivalent spectrum. That is axiomatic. Consequently any apparatus which will give data for securing the quantity and effective wave length will then serve for determining the depth dose, when the so-called Dessauer charts are given for effective wave lengths—as they should be.

This instrument has been assembled to provide an easily portable means for such comparisons. Its design and construction involve many complicated laws of the physics of X-rays and electricity; its working parts, however, are so arranged that thoroughly reliable readings for tests on X-ray equipment can be made by persons entirely uninformed about the factors which influence the details of its design. Different sized apertures and variation of intensity with target distance are used to adapt the testing outfit to any sort of X-ray tube, no matter what its output may be. The relative absorption of different filters is used to get at the effective wave length or spectral qualities of the rays being tested.

The entire apparatus is contained within an aluminum cabinet of about the same general dimensions as an ordinary suit case (Fig. 1). All parts are securely fixed in place except the ionization chamber, which

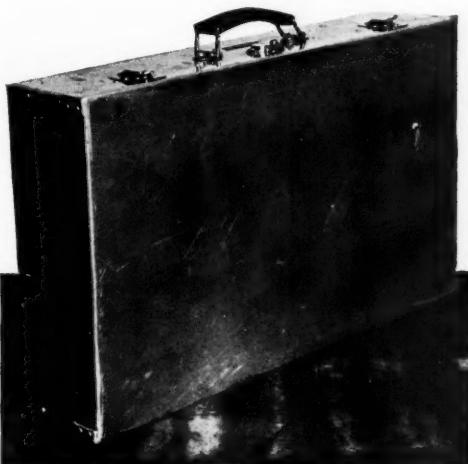


Fig. 1.

is permanently fastened to a fifteen-foot armored cable and may be lifted out of its compartment (Fig. 2). All the circuits of the apparatus are completely surrounded by a metal sheath which protects it from induced static disturbances or other similar effects. The apparatus weighs forty pounds, the greater part of which weight is due to several 22½-volt elements of signal corps type "B" batteries, such as are used in wireless work. This source of direct current was chosen so that there might be absolute independence from all outside influences, as well as simplification in the operation.

A small direct current voltmeter with a resistance in series with it serves to indicate the voltage which is impressed on the system. The resistance is placed in series with the voltmeter in order to lessen the current taken from the battery. The wir-

¹Read before the Radiological Society of North America, at Kansas City, December, 1924.

ing diagram is such that the voltmeter is in the circuit at all times when the instrument is in use (Fig. 3). This makes it certain that the voltage impressed on the

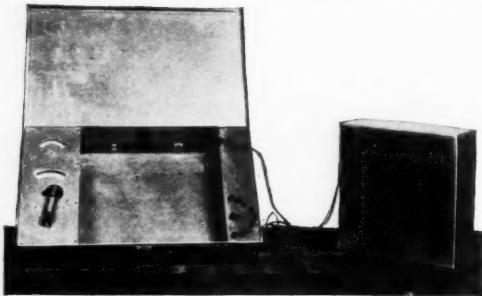


Fig. 2. Switch handle in position for closing.

ionization chamber system is the same as that which is measured.

Means are provided for testing the current calibration of the micro-ammeter, which is used to measure the X-rays, by checking its sensitivity against that of the voltmeter. The necessary connections for doing this are made when the double pole double throw switch is closed on the "test" side. The parts are so adjusted that the voltmeter indicates 60 and the micro-ammeter indicates 9 when the battery gives 125 volts.

It is never necessary to make leakage corrections because of the diverting of these currents out of the meter circuit. This is avoided through the splitting of the insulation into two stages by means of the triple conductor concentric cable and other special constructions.

The battery should be disconnected and the coil of the micro-ammeter lifted off its supporting jewel before the cover is closed previous to transportation. Failure to do these things might easily result in serious damage to the apparatus, so a mechanically interlocked system was developed which makes it impossible to close the lid until these things are done. The operating handle of the switch has an inner part which is rather massive and hinged, much as is the blade of a pocket knife; one end of it is so thick that it is impossible to close the

cover unless this raised part fits into a hole in the cover. This can only take place when the switch is in the mid-open position and the auxiliary handle folded over into a

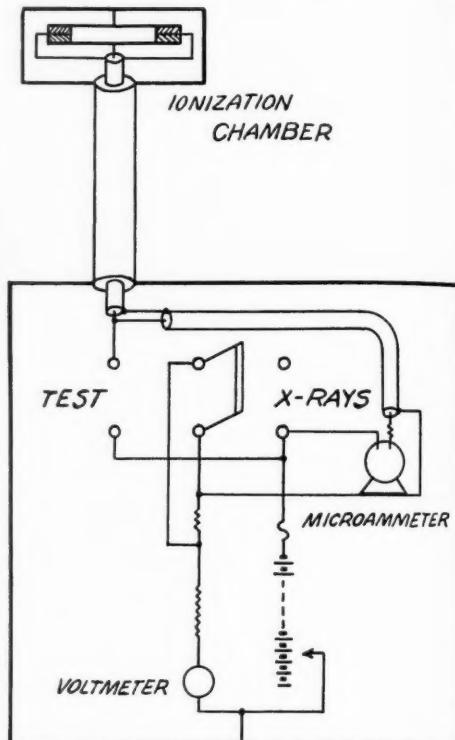


Fig. 3.

groove which is cut into the top of the coil-lifting button. This groove is cut in such a way that it will not engage the handle unless the button has been turned so as to raise the coil off its supporting jewel. The raised portion of the auxiliary handle will then go through the hole in the cover when it is closed. A 90° sector is also cut away from the rim of the coil-raising button of the micro-ammeter so as to insure that it will not be rotated too far when lifting the coil off its jewel. This cut-away sector works along the zero adjusting button.

The cable which is permanently connected between the ionization chamber and the rest of the apparatus provides great flexibility and enables the apparatus to be used

with any form of X-ray tube holder or container. The testing outfit requires absolutely no attention except to note the indication of the micro-ammeter after the X-ray machine controls have been adjusted to the desired settings. The tester may place himself and the instrument behind a screen, or even adjacent to the control cabinet in another room, where he can also operate the X-ray machine.

Portable testing units of this type are not primarily for the individual practitioner, but rather for the larger medical institutions, manufacturing, sales, and service organizations.

It goes without saying that these instruments should themselves be checked up at stated intervals or whenever they have been subjected to disturbing influences.

The variations among different installations and the idiosyncrasies of individual X-ray machines, discovered during the preliminary use of this testing instrument, seem amply to justify the trouble and pains which have been required to produce it. A full report of the influences which cause these disturbances is properly another subject and is not even briefly taken up in this paper.

Legg's disease.—This paper presents a case of Legg's disease involving one hip joint, having associated with it an osteomyelitis of the acetabulum. Acid-fast bacilli were demonstrated in the smear so that the osteomyelitis was presumed to be of tuberculous origin. The author is of the opinion that the presence of both conditions was merely coincidental and that tuberculosis as a factor in the etiology of Legg's disease need not be considered.

J. D. CAMP, M.D.

Osteochondritis Deformans Juvenilis—Legg's Disease—with Osteomyelitis of the Acetabulum, Probably Tuberculous. A Case Report. S. C. Davidson. *Am. Jour. Roentgenol. and Rad. Ther.*, Oct., 1924, p. 335.

by prying with a finger nail around the edge of the corn, a slight separation can be effected and after several days the corn can be separated as a whole. It can be picked off in pieces before it is ready to come off, but this is not advisable.

Corns removed by this method have not returned after a lapse of a year and a half. The same dose may be given to the sole of the foot as to corns on the little toe, or between the toes. Corns between the toes and soft corns have been removed by this method.

J. D. CAMP, M.D.

The Action of Roentgen Rays on Corns. A. Howard Pirie. *Am. Jour. Roentgenol. and Rad. Ther.*, Nov., 1924, p. 482.

Corns.—The author emphasizes the action of a large dose and that with a suitable large dose the whole corn comes off in one piece, leaving soft healthy skin behind with no vestige of a corn remaining.

The dose is 4 epilation doses applied in one sitting, using no filter. Expressed in electrical units the dose is 8 ma., 7 in. gap, 9 in. skin focus distance, 4 min. and 40 sec., with a broad focus universal Coolidge tube. Only the corn and no surrounding skin is exposed to the rays. This is accomplished by covering the foot with a sheet of lead in which is punched a hole just large enough to allow the corn to protrude through it. After the first few days of pain following the treatment, the corn becomes painless and in about a month after the treatment,

Radium therapy in cancer of esophagus.—The author sums up his experience over a period of fifteen years with radium treatment of 77 cases of cancer of the esophagus. In about one-third of the cases there was a remarkable improvement; in another third there was substantial improvement, and in the remaining third the improvement was either slight and fleeting, or there was no improvement at all, or the patient was rather worse than before. In three cases the procedure was followed by fatal results within a few days of the application of the radium.

SOLOMON FINEMAN, M.D.

Radium Therapy in Cancer of the Esophagus: The Results of Fifteen Years' Experience. William Hill. *Jour. of Laryngol. and Otol.*, Feb., 1925, p. 73.

A PROJECTION ELECTROSCOPE FOR QUANTITATIVE AND QUALITATIVE X-RAY MEASUREMENTS¹

By H. N. BEETS, M.S., Physicist, Michael Reese Hospital, CHICAGO, ILLINOIS

HERE is a demand among roentgenologists for a system of units of roentgen-ray quantity and quality which are independent of transformer and tube characteristics. The electrostatic unit for quantity and the effective wave length for quality have been introduced by Friedrich (1) and Duane (2), respectively, to satisfy this demand. How well these units serve their purpose is attested to by the enthusiasm of those roentgenologists who have employed the system. The use of these

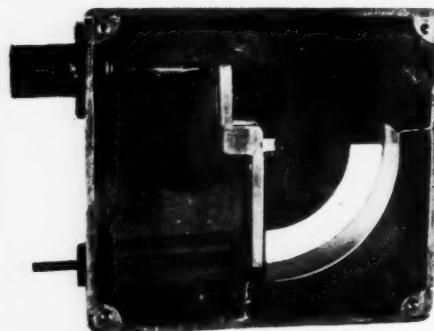


Fig. 1. Interior of electroscope.

units is not as widespread as it deserves to be. Perhaps the principal reason why these units are not more widely employed is the lack of a suitable portable instrument for their determination. A truly portable, light weight, compact, easily operated, and withal accurate instrument, the calibration of which can be checked by the roentgenologist against a small amount of radium as a standard, would encourage the use of the electrostatic and effective wave length units.

An electroscope designed by H. M. Elsey of the University of Kansas (3) combines the above-mentioned qualifications with this additional advantage, *viz.*, the image of the indicator and scale can be projected to any

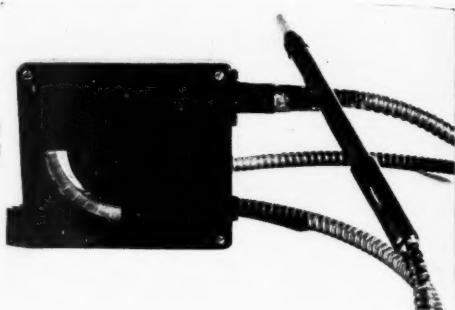


Fig. 2. Electroscope and Friedrich cable and chamber.

reasonable distance in a lighted room. This electroscope is similar to existing types but differs in that it may be readily inserted in the place of the slide carrier of an ordinary projection lantern. Elsey's electroscope was made originally for demonstration measurements in radio-activity, and the writer has made a few changes in design to adapt it for X-ray measurements.

The dimensions of the electroscope are 4½ inches x 5 inches x 1 inch. The frame (Fig. 1) is made of 1/8 inch brass, the faces of 1/16 inch sheet lead reinforced with 1 mm. copper to obtain rigidity. Mica win-

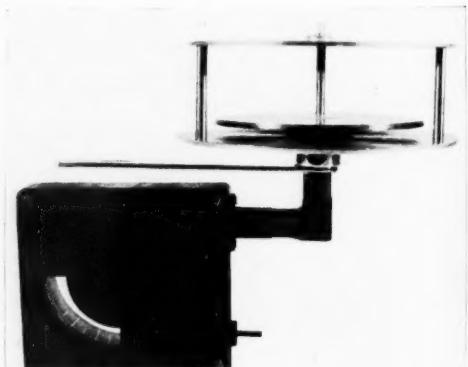


Fig. 3. Electroscope with parallel plate system.

¹Read before the Radiological Society of North America, at Kansas City, December, 1924.

dows permit the projection of the indicator and scale. The indicator may be either a rigid one on a jeweled movement or an aluminum leaf. (A leaf $\frac{1}{2}$ inch wide, 1 inch long, having a long, thin glass fiber attached to it with shellac will not turn to either side. This fiber extends $\frac{1}{2}$ inch below the end of the leaf and it is the shadow of the fiber that is projected.) The scale is etched onto the mica window. The indicator and scale are less than a half-inch away from each other and can be projected in good focus simultaneously. The standard on which the indicator is mounted is rigidly held by two threaded amber insulators with lock nuts, as shown in Figure 1. There are two accessory attachments, one a cable and Friedrich type ionization chamber (Fig. 2), the other a wall-less parallel plate ionization chamber (Fig. 3). The cable and small chamber are satisfactory for routine checks and for quality measurements. The wall-less chamber is preferable for absolute measurements of X-ray output as it eliminates the filtering action and the secondary electron effect of the walls of the small cylindrical Friedrich chamber. The parallel plate system is arranged with a rotating lead collar so that the direction of projection of the light and the direction of the X-ray beam may have any angle with each other. This system rests on the projection lantern (Fig. 4).

The electroscope-parallel plate system can be charged with an ebonite or sealing wax rod which has been previously rubbed

with wool or fur. The electroscope-cable system, though it has a much greater electrical capacity, also is easily charged with the sealing wax rod.

The calibration of the electroscope in terms of the electrostatic unit, and the cal-

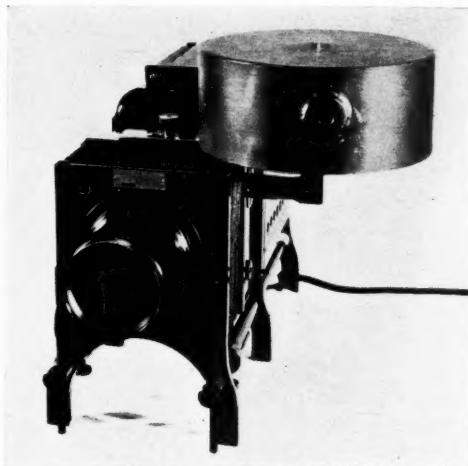


Fig. 4. Electroscope with parallel plate system as used with lantern.

culation of the effective wave length is made as with any electroscope (4) (2). The calibration once made can always be checked with a quantity of radium.

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Biological action of radiation.—The author discusses the effect which the quality of the radiation and the spacing of the treatments may have on the susceptibility ratio of tissues. Two important points are emphasized: (1) the necessity for the exercise of great care in experimental work of this kind; (2) the value to the radiologist of properly conducted experiments on animals.

This article does not lend itself well to abstracting, as a condensation of the closely related subject matter is quite apt to convey misleading conclusions.

J. D. CAMP, M.D.

A Brief Analysis of Some Important Factors in the Biological Action of Radiation. Gioacchino Failla. *Am. Jour. Roentgenol. and Rad. Ther.*, Nov., 1924, p. 454.

POINTS OF INTEREST IN THE OPERATION OF OIL-IMMERSED COOLIDGE TUBES AT 200 K.V.¹

By SANFORD WITHERS, M.D., DENVER

HIgh tension discharge tubes have been operated under oil almost as long as we have known of X-rays, so that no originality can be credited to my idea of using a deep therapy tube in an oil tank.

To be perfectly frank about the matter, I resorted to the method for economical reasons; and fifteen months' operation has convinced me that I was right in the assumption that the cost of installation and upkeep, and the convenience and safety of the method much more than justified the experiment.

The present equipment was installed in August, 1923. Prior to this time, I had operated two deep therapy machines, one with an open tube, and overhead high tension lines, at a low altitude; the other with the tube confined in a treatment couch, in an altitude of more than 5,000 feet. In this last installation great difficulty was experienced in preventing creepage along the tube at voltages in excess of 180,000, even with the most corona-proof terminals that could be devised; as soon as an appreciable film of dust collected upon the tube, bright sparks could be seen travelling from one end to the other. To eliminate this corona it was necessary then to open the couch, remove the tube and clean it thoroughly before each treatment. The inside of the couch had to be kept free from dust, as the fan for cooling the tube stirred up all dust particles and these were quickly deposited upon the tube.

In order, then, to get away from the use of an open tube with its corona, ionized air and the actual danger of shock, and to be free from the disagreeable features of a treatment couch, with the tube underneath or in a drum overhead, and because I was forced to use a small room for treatments,

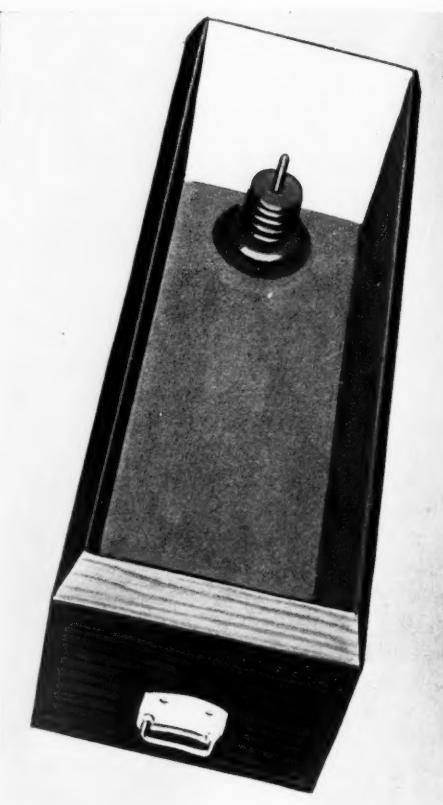


Fig. 1. Showing empty lead-lined box 14 x 14 x 42 inches. The electro's insulator with the brass collar that is soldered to the lead bottom of box is clearly shown.

I designed and installed the lead-lined oil tank that I shall discuss briefly.

Physicists and engineers of three of the principal X-ray companies were consulted and none of these furnished the data I desired in regard to the amount of oil necessary to insulate points at 200 K.V. and the amount of cooling needed for the tube. These technical experts emphasized the fact that the experiment would be costly, that it

¹Read before the Radiological Society of North America, at Kansas City, December, 1924.

OLIDGE

would be disastrous to operate an ordinary deep therapy tube under oil, and that some method would have to be devised for cooling the oil. On all three of these points they were wrong.

We found that three centimeters of Westinghouse "Grade A" transformer oil was more than sufficient to insulate points at 200 K.V., so we doubled this figure to get a factor of safety of 100 per cent and designed the box to give at least six centimeters clearance. The box was made 14 by 14 by 42 inches and lined with lead about 5/16ths of an inch thick. In order to properly cool the oil we had made four coils of quarter-inch copper tubing; the ends of each coil of twenty-five feet were brought out through the sides of the box and connected to suitable water service and sewer pipes. We later found that these water coils for cooling the oil were not only unnecessary but that they were in the way. The cost of these coils and the plumbing connections was more than the cost of the box and its lead lining.

The tube box as shown in Figures 1 and 2 is, then, larger than necessary by from one to two inches, and it requires about thirty gallons of oil to fill it. The tube is mounted upon the upper extension of the brass tube in the insulator that comes up through the bottom of the box. We designed terminals which allow a vertical adjustment of ten centimeters, and permit the tube to be rotated about its long axis.

It is difficult to make an oil-tight joint but this was accomplished by fastening a brass collar to the shoulder of the wall bushing type of insulator by means of machine screws, and soldering this brass collar to the lead bottom of the box.

The cover of the box is made of lead about 5/16ths of an inch thick over a frame of strap iron, and is in the form of a half cylinder (Fig. 3). The cover is supported to clear the box by journals at each end, which allows the half cylinder to be rotated through 60 degrees on its long axis. A set screw locks it at any desired angle from the vertical. The target of the tube is kept

centered under the treatment aperture by means of a fiber rod clamped to the cathode shank of the tube. This connection rotates the tube in its terminals as the cover is "rocked" from one side to the other. This



Fig. 2. Showing the tube in position. The brass tubes projecting above the insulators permit a vertical adjustment of the terminals of 10 cm.

device enables us to treat patients in semi-recumbent or Trendelenburg positions. In order to permit observations of the tube in safety we have placed a lead glass window in one end of the cover, through which the operation of the tube can be closely watched, as the oil is almost as clear as water.

It is fitting, here, to mention a little study on the movement of particles in an electric field. We observed that there was a marked current toward the surface of the oil (in

this particular instance) at both cathode and anode terminals. The oil appeared to be bubbling up as from a spring underneath, raising the surface about one centimeter at 200 K.V.

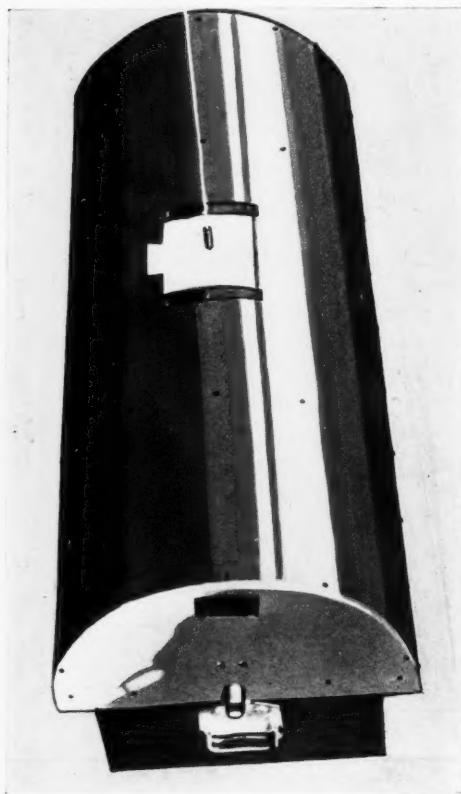


Fig. 3. Showing the box with lead cover which may be rotated through an arc of 60 degrees with the tube. The target remains centered under the plumb bob from the ceiling. The dark opening in the end of the cover is a lead glass window.

In addition to this, there was a marked current downward about the bulb that was rapid enough to draw suction vortices of two to three centimeters' depth and to produce waves two to three centimeters high on the surface of the oil over the bulb. This current was *downward* about the hot bulb in just the opposite direction to that of a convection current if produced by the heat from the target. These currents apparently bear no relation to the milliamperage through the tube, but vary in velocity

with the cathode stream. The movement of particles at the terminals of a discharge tube was described as early as 1899 (personal communication from Dr. W. D. Coolidge) and called a "liquid brush discharge," but I know of no adequate explanation for this phenomenon, as mentioned, unless it be due to the intense electric fields.

On account of the waves and vortices, above described, it is necessary to have the tube covered by five centimeters of oil—preferably six centimeters—and this depth is constantly maintained over our oil-immersed tube.

The operation of the tube is smooth, with none of the corona discharge variations as indicated by the milliammeter, which are constantly seen in air-cooled tube installations. The cooling by radiation from the box has been found sufficient for our needs even when we make a continuous run of six hours at eight milliamperes at 200 to 210 K.V. We believe that this method of cooling permits operation at six, or even eight, milliamperes with as great safety to the tube as previously obtained at four to six milliamperes. We are convinced that this method of treatment offers greater safety, protection, economy and convenience to patient and operator than any other installation that we have seen. The only disadvantage, that I know of, is that the procedure is new and that X-ray companies are therefore at a loss to know just how to install an oil-immersed tube.

SUMMARY

A forgotten method for obtaining insulation and cooling of "discharge tubes" has been revived, for which the following advantages are claimed:

That the method offers safety and protection for patient and operator from primary X-rays, noise, high tension lines and ionized air.

That the installation is more convenient and economical than any the writer has seen for the reasons that it is not necessary to clean the tube or its container, that the use

of a fan or blower to cool the tube is unnecessary, and that there is less chance of breaking the tube through handling and less likelihood of the development of strains in the glass through rapid heating and cooling, and improper connections at the terminals.

That the amount of space occupied is much less than is required in other installations, and the tube, treatment table and patient can be brought into the desired relations with a minimum of adjustment, so that patients may be treated in semi-recumbent or Trendelenburg positions, with little effort to them or to the operator.

DISCUSSION

DR. FRANCIS C. WOOD (New York): I would like to congratulate Mr. Kegerreis on the development of his apparatus for measuring X-rays; it is certainly a very valuable adjunct to our armamentarium. The sooner we all learn to work with accurate apparatus the sooner the differences we all find between each other's doses and the individual X-ray tubes will be explained; and if unpleasant accidents are to be avoided it will be necessary to fall back on just such measuring apparatus as Mr. Kegerreis has devised.

I thought that the best way to discuss Dr. Withers' paper was to show some slides from an apparatus of my own (Fig. 1). Dr. Withers and I have compared notes in devising the system. In the first place, he and I were influenced by much the same motive, that is, poverty. The slides show an installation built at a cost of about four hundred dollars for the two oil tanks. The machine is in a room from which the two high voltage lines run into the tanks. The room is sealed so that no noise comes from the motor; the patients do not know when the X-ray is turned on and when it is turned off, and they often complain that they have not been treated because they have not heard anything. These boxes are built of oak by an ordinary carpenter and are on rollers, so that they can be moved around. They are lined with quarter-inch lead and a six-inch square sheet of copper

one-half millimeter thick is soldered into the bottom of the tank; therefore the filters can never be left out. You will see little lugs on the legs of the tanks which are ten

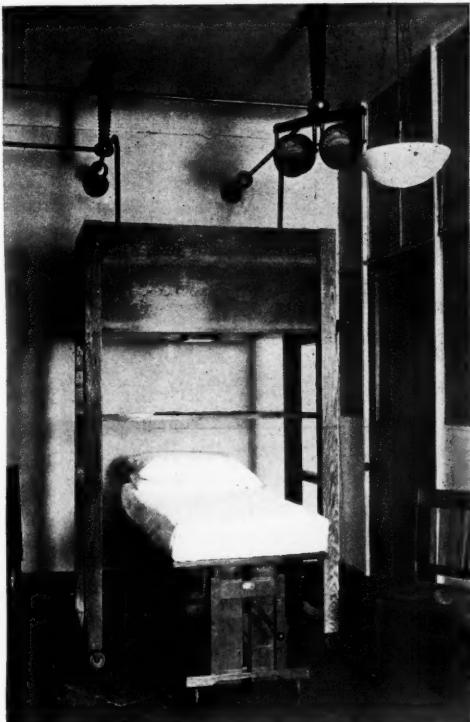


Fig. 1

centimeters apart and a small frame leaning against the wall. That is so we can put the frame into position and use it to support secondary lead screens with a variety of apertures. There is a filter holder screwed to the bottom of the tank so that an additional sheet of aluminum or copper can be inserted if desired. Test photographs have shown that very little X-ray gets through the lead walls. It is absolutely unnecessary to cool the oil. After the tube has run for eight hours the temperature of the oil, which measures about 55 gallons, will be only some 90°F. In other words, the system is self-cooling. The life of the tubes has been admirable and they do not have to be cleaned. Two tubes in these tanks have now run untouched for a year and a half at 190

to 200 kilovolts and 5 milliamperes. There are two movable tables, a high and a low one, also made by a carpenter. They are not adjustable as to height. The dosage is easily determined by measuring the distance from the bottom of the tank to the patient's skin. The human erythema dose having been found by exposing animal tumors, a chart is made on double logarithmic paper of the inverse square law, using the known erythema as a basis. The chart reads centimeters distance on one co-ordinate and time on the other. Thus, for any skin-focus distance the time of an erythema or suberythema dose can be instantly read. One table gives a skin-focus distance of about 55 cm., the other about 70 cm. The tube is always run at the same voltage and the same milliamperage. There are additional charts for other voltages, so the whole matter of dosage measurements becomes mechanically very simple. A fluorescent screen can be laid on the patient's skin, and the area to be rayed adjusted by moving the secondary lead screens around by hand so as to get the exact area. The oil between the tube and the filter screens off a great deal of X-ray, so a thin glass beaker containing air is placed below the tube. There is thus very little absorption of the direct beam and the scattered radiation from the oil is added to the direct beam, thus giving more radiation than when the tube is running in air. The whole outfit has been extremely satisfactory, and as the tank is grounded no one can reach any charged line.

DR. ULLMANN (Santa Barbara): I would like to ask Mr. Kegerreis if his instrument is calibrated so that it can be read directly in electrostatic units, and Dr. Wood if he can handle a patient who can neither sit up straight nor lie down flat or on his side. There is one thing that impresses me in regard to ionization measurements. Back in 1920-1921, when every one was measuring his voltage with a point gap which varied not only with the temperature of the air, but with the man who was doing it, his

feelings, character, etc., I pled for the use of accurate methods of measuring, and that we all take the definite electrical term of "volt" instead of "inches gap." I succeeded in putting that over; we are all using sphere gaps to-day, and I am wondering if perhaps a great part of our difficulty now is not due to the use of ionization chambers to measure something, but that something varies with everyone who is using it. Therefore why can we not, as a Society, report so many electrostatic units or whatever other units the electrical engineers say is the correct thing, and not talk about so many minutes to the fall of a leaf, etc. Let us all speak the same language, and perhaps we will find out that many of these differences will be ironed out, just as other differences were ironed out when we began to speak of volts instead of inches gap.

DR. ARENS (Chicago): I want to compliment the physicists on their presentation. About four years ago I came back from Europe with the idea that we had all overlooked something in the little town of Freiburg. I brought this idea back, and I thought it might be a good thing to use. I put the proposition in the hands of a physicist and we started to work on it. We have been discussing this matter of the electrostatic unit for four or five years; I have advocated it in an informal way before many members of the Society, but they have not proved very receptive. We have been working on it and finally have come to our own conclusion that the old scratch unit is a definite and logical unit. We have used it in our work, and we have stayed away from any serious roentgen dermatitis.

A year ago we reported on some work that we have done; we reported on a series of X-ray tubes checked up by means of utilizing the electrostatic unit. We took a number of tubes, new tubes, old tubes, checking them up under the same apparatus and under identical conditions, and we found that while new tubes gave an output within 2 per cent of one another, old tubes varied up to 37 per cent from the output

of a new tube. Now, fortunately, the variation was on the side of smaller quantity of X-ray output. That meant that if one used a new tube up to its maximum point and then used an old tube, he would be on the safe side, but the number of hours which that tube had been used was no indication as to how much it had slowed up as far as quantity was concerned. Suppose, on the other hand, we had been using the old tube, had that checked very carefully as far as our biological results were concerned, and then used a new tube which delivered about a third more in X-ray quantity: we would have had some disastrous results.

I want to join Dr. Ullmann in making a plea for the electrostatic unit for this Society, or establishing some other definite unit to be decided on by the physicists working in this field for a logical basis to work on, so that we can all talk the same language.

DR. A. MUTSCHELLER (Long Island City, N. Y.): I believe that everyone here present is in full agreement with the fact that success in roentgen therapy depends to a very large extent upon the accuracy and reliability of measuring methods, and, therefore, every attempt to develop measuring methods and make them more accurate and dependable is to be highly commended. The ionization chamber has many good qualities, but it also has many faults. The various types of ionization chambers that have been described are each individually applicable for one particular type of measurements. The iontoquantimeter is applicable for quantity measurement but not for quality measurement. The small beam ionization chamber is applicable for determining the correct filter thickness, average wave length, etc., but not for the determination of quantities of radiation. Another reason why the ionization chamber is not exactly the best instrument is that with it an effect produced by X-rays is measured, and these effects as a rule are selectively sensitive for different wave lengths and therefore the readings of the electroscope or meter, whichever may be used to deter-

mine the ionization current, are not linearly proportional to the intensity of the X-ray beam at various different voltages. My attempts in this direction have led me to undertake to use a somewhat different method which depends on the conversion of X-ray energy into another measurable form of energy. In the laboratory, the bolometer, or heat-measuring instrument, has been used repeatedly for the measuring of the heating effect of X-rays, and although this instrument has not been developed to any such stage that it could be employed in the clinical roentgen-ray laboratory, some very interesting measurements have been made which indicate that clinical results would be much more easily interpretable if the measurements were made with an energy-measuring instrument such as the bolometer. I cannot say at the present time whether this instrument can be developed to such a stage of perfection that it can actually be used in the clinical laboratory, but from a general survey it seems that when this instrument is perfected, not only more information can be obtained, but of a more valuable and dependable nature. The electrostatic unit has been suggested repeatedly as a unit for X-ray measurement, and somehow or other it has not been universally adopted. This seems to me to be due to the fact that it is too difficult to standardize an ionization chamber in electrostatic units, and, if once standardized and carried about, there is no assurance that the instrument is not out of adjustment. A bolometer, on the other hand, can be easily standardized and I hope I will be able in the near future to report further progress on this instrument which, in my opinion, would probably make accurate and dependable measurement much more readily feasible.

DR. DESJARDINS (Rochester, Minnesota): In listening to these different papers I have been struck by one thing. Some radiologists use one unit of measurement, some another, and, apparently, some have no unit at all. For instance, much has been made of the Roentgen, of Solomon (someone else

in Germany has another Roentgen which is different from that of Solomon); of the electrostatic unit, such as used by Krönig and Friedrich. Since the physicists themselves cannot agree on what is the most desirable unit by which to measure X-rays, I certainly would not venture on that ground. However, it is of extreme importance that we learn to talk the same language, and, since that requires that a given unit be generally adopted, it has occurred to me that, since there is to be next year an International Conference on Radiology, it would be well that this subject should be taken up at that time with a view to the adoption of a standard international unit of measurement.

MR. KEGERREIS (closing): It might again be emphasized in connection with the paper of Mr. Beets, as well as my own, that these different instruments will do the same thing but are primarily made up for different purposes and accordingly are to be handled in different ways.

Dr. Withers' experiences with the effects of high altitudes are more impressive than what we ordinarily encounter at moderate barometric pressures, but the phenomena are of the same class. At the higher altitudes the air is not so dense and charged particles can be moved much easier in it; we say the mobility is increased. The speed with which a charged particle will move also depends on the voltage and the shape of the terminals on which the electric potential is impressed. Another way of stating this is to say that the movement of the ions depends on the electrostatic stress in the different parts of the field.

It might be worth while to try to design some sort of external apparatus to put about the X-ray tube in order to redistribute the electrostatic stress. A tube very often fails because the electrostatic stress becomes localized and punctures it, as we say. Two very notable commercial products depend on the principle of properly distributing the stress. They are the Nicholson ring, which we see on high voltage insulators, and the condenser type outlet insulator bushing.

The movement of the oil which has been noted by Dr. Withers comes in the same class of phenomena as a similar movement in gases. I gave a paper on this subject at the April meeting of the American Physical Society. Professor Zeleny of Yale University first called attention to it in 1898, which goes back a year or so more than did the reference of Dr. Withers. Professor Zeleny showed that there are flurries of air between the two plates of an ionization chamber when it is in use. The paper by myself was about a method of using these currents of air to measure the ionization current itself. Similar considerations apply to liquids, and I have before suggested that one might build a perfectly good high voltage voltmeter by utilizing the very currents that have been observed by Dr. Withers.

There was some surprise exhibited when it was stated that an X-ray tube could be run in a tank of oil without having some added method for cooling. Five milliamperes at 200 peak kilovolts as delivered from the ordinary X-ray machine is about 300 watts, because of the wave form and arc of contact coming in. Three hundred watts for one hour equals 258,000 gram calories; this energy would increase the temperature of fifty gallons of oil by a little less than 3°F.

Dr. Wood showed an extra aperture rather well below the bottom of his tube holder. That is a good thing, since the beam is then cut off more definitely. The depth dose depends very much on how large the aperture is and where you have it.

The direct answer to Dr. Ullmann's question is "No, the instrument does not give 'E' units directly." It is perhaps appropriate that a word be said about X-ray measurements and a unit for X-rays. The sphere gap is a good thing and is about all that we have to measure high voltage with. Errors of 5 and even 10 per cent may easily come in, in such measurements. High voltage measurement by means of a sphere gap is at best a rather indefinite thing, since there is generally no other means at hand for checking purposes and so one does not

know if there are errors or not. The profession will benefit tremendously when someone devises a reliable instrument for measuring high voltage. The X-ray intensity varies approximately as the square of the voltage, so the X-rays are "off" 10 per cent if the high voltage is in error by 5 per cent, etc.

Anything which an ionization chamber gives depends on the X-rays absorbed within it. It is necessary that the ionization chamber be deep enough to not let one iota of X-rays go through it, if a correct and absolute measure of them is desired. Every ionization chamber which I have seen allows some of the more penetrating X-rays to pass through it without being absorbed; a lesser indication is accordingly given to the penetrating rays. Some of the measurements which were generally accepted in physics are now being questioned, because we are coming to realize that those measurements were made with ionization chambers that were very efficient absorbers of soft X-rays but not so for the more penetrating ones.

The electrostatic unit is no more a measurement of X-rays than if you were to pay your electricity bill in terms of ampere hours instead of kilowatt hours. The electrostatic unit is about the only fundamental thing we have with which to connect ionization measurements, but unfortunately the idea has crept in that it is the whole story. There never will be some one thing that can be used as a unit of X-rays. If you absorb them and use the electrostatic unit and also give the effective voltage or wave length, all is well. If you do not specify the voltage or something which depends on it, the electrostatic unit means nothing.

Ionization chambers which are constructed of low atomic weight materials give data

which are most comparable to biological effects over wide ranges. The thing which makes the apparatus described work, is the fact that tin has been used on the plates of the ionization chamber. I have found that the secondary rays from the tin are most efficient ionizers of air near the plates, and that is the thing which makes it possible to get ionization currents of sufficient magnitude to operate a meter with a pointer.

The measurement of X-rays by means of heating effects, as suggested by Dr. Mutscheller, requires apparatus of great sensitivity and is beset with many difficulties. It also has a great fundamental disadvantage in that time must also enter.

In conclusion, I want to state emphatically that the measurement of X-rays is a complicated thing and that there is no one simple entity which will serve alone to specify X-rays.

MR. BEETS (closing): I want to emphasize a statement made by Mr. Kegerreis, and that is that the electrostatic unit is *not* the whole story. It is a unit analogous to the ounce or the cubic centimeter; that is, it has reference to the quantity of the X-rays. If, in addition to quantity, we state the quality of the radiation, then the X-ray dose is well defined. The quality of X-radiation can be, I think, fully expressed in terms of Dr. Duane's effective wave length system. Thus we can speak of 100 electrostatic units of 0.15 Å effective wave length, or 100 electrostatic units of 0.22 Å effective wave length. We know that their distribution in the body will be quite different, but the space distribution of these different qualities of radiation, and therefore their resulting biological effects, is something that can be determined in the laboratory.

RELATION BETWEEN THE PHYSIOLOGICAL DOMINANCE AND THE BIOLOGICAL EFFECTS OF RAYS¹

By WILLIAM T. BOVIE, Ph.D., CAMBRIDGE, MASS.

I DISCUSSED the relation between the physiological dominance and the biological effects of rays before the American Roentgen Ray Society in Swampscott, Massachusetts, on September 3, 1924. The time allowed for my paper at the Swampscott meeting permitted me to go into the subject in more detail than I will be able to do at this time. The discussion in Swampscott will be printed in the *American Journal of Roentgenology and Radium Therapy*. Both of these discussions are based upon the results of some experiments which were formally presented to the American Association for Cancer Research at Buffalo, New York, in the Spring of 1924.

The relation between physiological dominance and susceptibility to radiation is of peculiar interest to the clinician because of its bearing on the rationale of the treatment of cancer by radiotherapy. Physiological dominance is correlated with metabolic rate and it is a quite generally accepted biological fact that a high metabolic rate and susceptibility are also correlated.

That we demonstrated such a correlation in our experiments does not constitute a novel contribution. However, we do believe that our experiments are unique because of the fact that our biological material consisted of a single-celled organism, *Amoeba proteus*, and we have been able to correlate susceptibility with stimulation gradients, metabolic gradients and physiological dominance and to describe the correlation in terms of the simple mechanics of photo-chemistry.

Stimulation gradients, metabolic gradients and physiological dominance are characteristics of all living organisms, including both animals and plants. By suitable methods of experimentation they may be demonstrated in the single-celled proto-

zoa and protophyta, in the metazoa and metaphyta, in the colonial organizations of both animals and plants, and in the social organization of the higher vertebrates, including man.

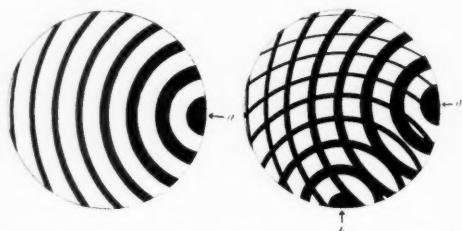


Fig. 1. Diagram illustrating the origin of a single axial gradient in protoplasm; *a*, the point of action of the external factor. (From Child.)

Fig. 2. Diagram illustrating origin of major and minor gradients in a simple case; *a*, apical region of major gradient; *b*, apical region of minor gradient. (From Child.)

Figure 1 is from a book by Child on the "Basis of Individuality in Organisms," published by the University of Chicago Press, 1915. It is a diagrammatic representation of a stimulated amoeba after a period of complete rest. All pseudopods have been withdrawn and the protoplasm has contracted into a sphere. In a resting condition all stimuli are supposed to have disappeared so that the state of metabolism is homogeneous throughout.

Now, suppose that the amoeba is irritated at the point *a*. As a result of this, stimulation will be increased at this point but the stimulus is propagated throughout the mass of protoplasm; and, unlike the propagation of the stimulus along a nerve which is normally without a decrement, in the amoeba the stimulus is propagated with a decrement. That is, the intensity of the stimulus falls off with the distance, from the point of irritation. This is indicated in the diagram by the varied widths of the concentric lines. It is supposed that the stimulation

¹Read before the Radiological Society of North America, at Kansas City, December, 1924.

gradient is the cause of the metabolic gradients referred to above.

The amœba under normal conditions will throw out a pseudopod at the point *a* which will now become the anterior end of the organism. The opposite pole of the amœba is the posterior end. The mass of protoplasm is no longer homogeneous with respect to stimulation or to metabolism. It has acquired a bi-polar organization, an anteroposterior differentiation. There is a metabolic gradient sloping downwards from the stimulated to the non-stimulated end.

Suppose now that this organized amœba is further irritated at the point *b*, Figure 2. (From "Basis of Individuality of Organisms," Child.) Since the rate of metabolic activity is not so high as at the point *a*, the effectiveness of this stimulus will be less than that of a similar stimulus applied at the point *a*. That is, the point *a* having already been stimulated and having gained metabolic ascendancy is able to maintain its dominance until either the metabolic activity dies down or until a sufficiently strong stimulus is applied at some other point.

I fancy that just what we mean by increased rate of metabolism is not always clear in our minds, but I think that we understand the expression well enough so that I do not need to take time to define it. There are a number of methods which have been used in measuring the metabolic rate. One of these methods is based on the fact that tissues which have a high metabolic rate are more susceptible to poisons.

Child has made use of this fact and has used the degree of susceptibility to poisons as a measure of metabolic rate. This seems a very reasonable thing to do. In his investigation Child used some fifty-odd species of animals, but, as you remember, he did most of his work with planarian worms. The animal is simply immersed in a solution of a poison. Destruction begins in that part of the animal having the highest metabolic rate.

Child, in his experiments, using a solution of potassium cyanide of a suitable con-

centration, found that in the case of the planarian worm destruction begins at the anterior end. This is one of a number of things that indicate that the metabolic rate is greater at the anterior end of the worm than at the posterior end.

Now, an amœba of the proteus type when moving in a homogeneous medium and thus undisturbed by external stimuli sends out pseudopods which, quite regularly, are formed, first, on one side and then on the other of the general line of progress, so that the organism follows a characteristic zigzag course. The pseudopods flow out from the anterior end. As new pseudopods are formed and the amœba advances, the older pseudopods gradually come to occupy a more and more posterior position and are gradually withdrawn into the body of the amœba. Thus, the posterior pseudopods are the oldest. We would, of course, refer to the advancing end of the amœba as the anterior end. The end that drags behind is the posterior end. More specifically, the advancing end of each pseudopod is its anterior end as it is formed.

If now we analyze this peculiar amœboid motion into components we will refer to the advancing tip of each pseudopod as a temporary anterior end. As each pseudopod protrudes it is obvious that the tip is younger than its base and we may, therefore, refer to the base of a pseudopod as being posterior to its tip. Thus, each pseudopod is a temporary individualization of the amœba protoplasm. This individualization is characterized by a physiological and morphological differentiation into an anterior and posterior region. The organization is of the simplest type. It is a temporary polarity which extends along the longitudinal axis. Each pseudopod may, therefore, be compared with the organization of a complete planarian worm. Now, according to our notions of physiological dominance we would expect that the anterior end of the advancing pseudopod would be physiologically more active, *i.e.*, have a higher metabolic rate than the posterior or basal region of the pseudopod, and thus

there is a metabolic gradient along the axis. This gradient slopes from the anterior down to the posterior end of the pseudopod.

We may transfer this idea to the amoeba as a whole. The entire organism has a bipolar organization represented by anterior and posterior ends of a longitudinal axis. There is a metabolic gradient along this axis and as in the individual pseudopod this gradient slopes downward from the anterior toward the posterior end of the amoeba. This major gradient is of course modified by the ever-changing minor gradients which accompany the individualization of the protruding and retracting pseudopods.

Let us now consider the age of these amoeboid individualizations. The most recently formed pseudopod is younger than the pseudopods which have been formed previously, notwithstanding the fact that it has been formed out of protoplasm the constituents of which are of an infinite number of ages, some of which may extend into the remotest past.

I cannot refrain from interrupting my argument for the purpose of impressing on your minds the significance of this concept. We can, of course, refer to the age of each granule of the protoplasm as measured by the length of time that has elapsed since it was formed out of the food ingested by the amoeba. Many cell divisions may have occurred since this granule of protoplasm was formed. Indeed, such is the immortality of protoplasm that this ingestion may have occurred many years ago as we measure time. Granules of amoeba protoplasm which have existed for many lengths of time are ever mixed by the endless flowing of the protoplasm. They find themselves components of an advancing pseudopod and through the metabolic activity of the protoplasm and the anteroposterior polar organization they now form a part of an individualization that has never existed before. This gives us a new and pregnant insight into the nature of rejuvenescence.

Let us return to the age of individualization. Figure 3 is an outline drawing of an amoeba advancing in the direction of the

arrow. The posterior end is at *p*. The most recently formed pseudopod is Number 1. The other pseudopods are numbered serially in accordance with their ages. Pseudopod Number 5 has been almost en-

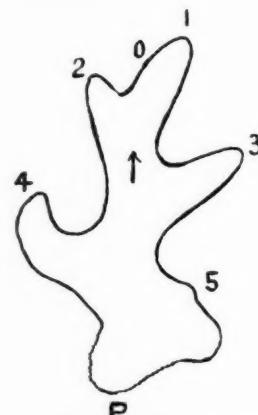


Fig. 3. Diagram showing an amoeba advancing in the direction of the arrow (original drawing).

tirely withdrawn into the body. It has, therefore, almost practically ceased to exist as an individual. A pseudopod is about to be formed at the point marked 0. As a precursor to the formation of this pseudopod an increase in metabolic rate has already occurred at this point. The increased metabolic activity has been initiated by the stimulus which in this case, we suppose, has originated within the protoplasmic mass, and we believe that the area of enhanced physiological activity has been localized through the influence of the metabolic gradient which extends throughout pseudopod Number 1.

If I may recapitulate the individualization of a single pseudopod, there is a bipolar organization along the longitudinal axis of the protruding lobe of protoplasm, and a metabolic gradient along this axis with the highest metabolic rate at its distal or anterior end.

If one observes an amoeba in the pursuit of its prey it is not difficult to be convinced that the anterior end of the pseudopod controls or dominates the activities of the entire organism. If, for example, an infuso-

rian sweeps past the amœba under conditions such that the amœba is stimulated to pursue, one observes that the stimulated pseudopod advances rapidly along the path of the pursued infusorian, and, further, that

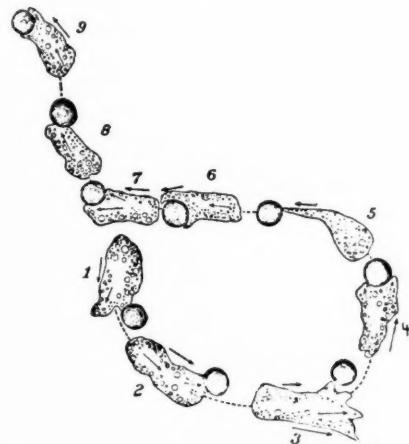


Fig. 4. Diagram showing an amoeba following a rolling Euglena cyst. (From Jennings.)

the formation of other pseudopods is inhibited. If the stimulus be great enough all pseudopods excepting the one stimulated are soon withdrawn and the amœba assumes a clavate form and pursues the fleeing organism with what, by analogy, we might call an undivided purpose (See Fig. 4, from "Behavior of Lower Organisms," by H. S. Jennings, Columbia University Press, 1915).

The amoeba becomes elongated in the direction of its motion. A pursuit of this kind may continue for fifteen or twenty minutes, during which time the amœba has a single, axial, metabolic gradient; that is to say, that the stimulated pseudopod has suppressed all other metabolic gradients. It is in this sense that the stimulated pseudopod dominates the pseudopod formation of the organism. It will be observed that this dominance is correlated with and is the expression of a localized heightened metabolic activity (See Fig. 5, from "Behavior of Lower Organisms," by H. S. Jennings, Columbia University Press, 1915).

If we may measure metabolic activity by observing the susceptibility to poisons we would expect, when we subjected an amœba to a poison such as a solution of potassium cyanide of suitable concentration, that the

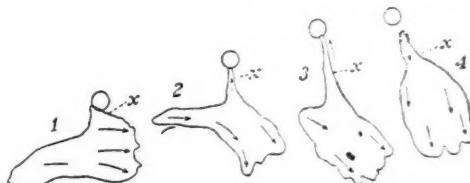


Fig. 5. Diagram showing a single pseudopodium (*x*) reacting positively to an *Euglena* cyst, its protoplasm flowing in the direction of the cyst and pushing it forward, while the remainder of the amoeba moves in another direction. 1-4 successive forms taken. At 4 the reacting pseudopodium is pulled away from the cyst, whereupon it contracts. (From Jennings.)

destruction of the protoplasm would begin at the anterior end of the pseudopod and that the wave of destruction would be propagated backward toward its base. This is precisely what Miss Hyman set forth in her article, "Metabolic Gradients in Amœba and their Relations to the Mechanism of Amœboid Movement," published in the *Journal of Experimental Zoology*, 14:55, 1917-18.

With this introductory discussion I may now describe the experiments that we have conducted in order to demonstrate the relation between physiological dominance and susceptibility to radiation. The experimental procedure is very simple and the implication of the results of the experiments will, I am sure, be readily understood.

A microscope provided with a quartz condenser and a right-angled prism for reflecting a beam of ultra-violet from a monochromatic illuminator was used. The source of light was a spark between specially devised, rotating, self-cooled magnesium terminals. The organisms were mounted on a quartz microscope slide. The wave length of light used was 280 m μ . The intensity of the beam was sufficient to cause cytolysis in about three seconds.

When we thus exposed an amoeba to ultra-violet light we found that cytolysis in

77 per cent of the cases began at the tip of the most recent pseudopod. The following table gives the results of a number of experiments:

Cytolysis began:	No. of trials	Pct. of trials
In last pseudopod.....	50	77
At base last pseudopod..	11	17
More or less central.....	2	3
Posterior end of amœba....	2	3
	65	100

Bearing in mind the difficulty of watching the entire body of the animal at the same time, these results seemed very demonstrative. In only 6 per cent of the exposures did the cytolysis begin at a point far removed. In 17 per cent of the cases the disintegration began near the base of the youngest visible pseudopod, though no actual protrusion was observed in any of these cases. It seems reasonable to suspect that these were regions of incipient pseudopod formation, for these were quite surely the regions where such pseudopods would originate. That cytolysis began at the advancing tip of the amœba in 77 per cent of the cases and probably in 94 is interesting. In other words, cytolysis began at the point of highest metabolic activity and in that region of the organism where physiological dominance was highest.

We anticipated that the results of this experiment would be particularly interesting because we had stimulation gradients, metabolic gradients, physiological dominance and susceptibility all within the confines of a single cell. This makes it possible to carry our analysis of the phenomena a little farther.

When we say a high metabolic activity, if we mean anything, we must mean that chemical changes are occurring more rapidly where metabolism is high than they are in places where metabolism is low.

Ordinarily we increase the rate of chemical reactions when we raise the tempera-

ture. It is a general rule that an increase in the temperature of 10° C. doubles the velocity of a reaction. Now it was pointed out a long time ago by Arrhenius that this phenomenon cannot be accounted for by supposing that the mechanism connecting the increase in velocity with the increase in temperature is the number of kinetic collisions between the reacting molecules, because the increase in velocity is much too great to be accounted for in this manner. Arrhenius, therefore, proposed the theory that at any one time only a fraction of the atoms or molecules of a reacting mixture are in proper condition to permit chemical reactions. As he pointed out, we have evidence of this in the fact that most chemical reactions do not proceed with an explosive velocity as would be the case if this were so. Arrhenius supposed that the increase in temperature brought more of the atoms or molecules of the reacting mixture into a condition suitable for chemical rearrangement. In other words, any reacting mixture contains two kinds of atoms: those which are chemically passive and those which are chemically active.

If now we accept what we may call the twentieth century theory of radiation and sub-atomic structure, those atoms which change from the chemically passive to the chemically active condition do so through absorbing within themselves a number of quanta of energy. This energy is absorbed from the radiation environment of the atom. The size of the quanta absorbed is proportional to the vibration frequency of this radiation environment. In the now familiar jargon of the sub-atomic physicist the

$$\text{quantum} = h \nu$$

in which h is a constant and ν is the vibration frequency, so that the higher the vibration frequency of the radiation environment, or the farther it lies in the ultra-violet end of the electro-magnetic spectrum, the larger will be the size of the quanta of the energy units absorbed.

Now the exact mechanism by which the radiation is absorbed and the whole series

of changes which occur in the atom as the result of the absorption are at present unknown, but it appears that in the end the electron comes to occupy an orbit which is more widely flung from the atomic nucleus. The absorbed energy becomes potential energy of position of an electron and in the case of the chemically activated atom it appears that this electron is a valency electron.

Now we may state our metabolic gradient in a new language. An increase in the metabolic rate means an increase in the velocity of chemical reactions and an increase in the velocity of chemical reactions means that a larger fraction of the atoms are in a chemically active condition, and this means, in turn, that a larger fraction of the atoms have their valency electrons traveling in far flung orbits. That is to say, they have absorbed energy from the radiation environment and we believe that this energy has been absorbed discontinuously in units of definite size which are called quanta. All these quanta are related to the vibration frequencies of the radiation environment.

Now in a living organism it appears that some other mechanism aside from temperature is involved in determining the fractional part of the atoms or molecules that are in a chemically active condition because chemical reactions proceed much more rapidly in living protoplasm than they do in dead protoplasm at the same temperature. We have a general name for this fact, but no general theory. We say that the velocity of the chemical changes in living protoplasm is increased by the presence of so-called catalysts, but how the catalyst, or enzyme, as it is usually called, activates the atom is at present unknown.

Now, I believe that one of the fundamental differences between the chemical reactions which occur in test tubes and those which occur in living protoplasm will be found to be correlated with the fact that protoplasm is organized. In the organization of protoplasm it appears that we have

a mechanism for maintaining a larger fraction of the atoms in a chemically active condition than we normally find at the same temperature in a homogeneous reacting mixture in the test tube. We must believe that the atoms, and, therefore, the molecules of protoplasm, because of the peculiar organization in which they are found, are maintained in a chemically active condition. In other words, they are alive; alive in the sense that they are continually taking part in physiological changes. This, I take it, is what we mean by living.

I believe that a large part of this enhanced chemical activity which is shown by living protoplasm can be correlated with the fact that protoplasm is a polyphase colloidal system. That is, it is composed of materials that are finely divided and that are immiscible with each other. The result is that protoplasm, like colloids in general, has a high specific surface. By the word "surface" I refer, of course, to the interfaces between the immiscible constituents of the protoplasm. And by "specific surface" I refer to the amount of interface per unit volume of protoplasm. The expression, "high specific surface," therefore, refers to the fact that with a given volume of protoplasm there is much more surface or interface than there would be in the volume of a standard reference substance, such, for example, as an equal volume of water.

Now, many of these immiscible constituents have dimensions below the resolving power of the microscope. Some of the larger granules can, of course, be seen in the living protoplasm of an amoeba. The granulation seen in fixed and stained sections of protoplasm may be artefacts. The immiscible granules at the interfaces in living protoplasm may be most readily studied by means of ultra-violet photography of living protoplasm. This is illustrated by Figure 6, an ultra-violet light photograph of a living amoeba. The photograph has been made by the same ultra-violet ray which was used in the experiment described above. Figure 7 shows the same amoeba as

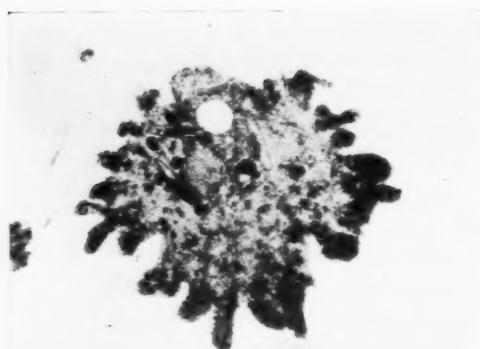


Fig. 6. Diagram showing an ultra-violet light photograph of a living amoeba (original drawing).

shown in the previous figure after fifteen seconds' radiation.

In the light of the previous discussion we may state that the ultra-violet energy changed the atoms and molecules of the protoplasm into a more chemically active condition, so that chemical reactions occurred at destructive velocities. As you see, the end-result has been that the portions of the protoplasm which were immiscible before the exposure to the rays have now become miscible, so that they have flowed together and the interfaces have been lost. That is, the protoplasm has lost this peculiar organization which is characterized by a high specific surface and it is no longer a suitable medium for maintaining the chemical reactions which are characteristic of the living condition.

This rather roundabout way of saying that the light has caused the amoeba protoplasm to cytolize carries a much deeper insight into the nature of the process than the shorter expression "photo-cytolysis."

DISCUSSION

DR. J. E. GENDREAU (Montreal): To produce chemical activity one can bring into consideration several factors; for instance, not only proper heat but also the mere presence of life in a body will increase its actual chemical activity so that

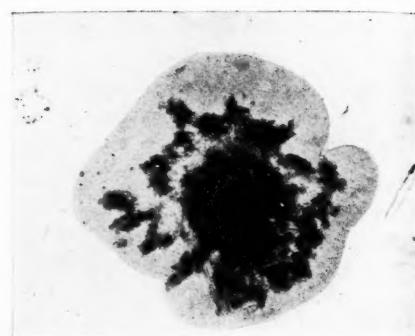


Fig. 7. Diagram showing an ultra-violet light photograph of the same amoeba after fifteen seconds of radiation (original drawing).

its cells and molecules will respond to an amount of absorbed energy insufficient to produce the same reactions *in vitro*.

Hence the admission of a certain "quality factor" that might suggest a working hypothesis upon which I would like to ask Dr. Bovie's opinion. Is it not possible to admit that not only the *quantity* of absorbed energy but also its *quality* can come into action in the production of actual chemical activity? In fact, it is often easy to communicate to the tissues a fixed amount of energy, but if you want to react over them in a specific way, you must utilize a selected *quality* or kind of energy, a determined wave length, that alone would be absorbed.

The establishment of valency in the external electrons, or the action on the deeper electrons in the atom may require the absorption of energy under very *definite*, not under *any*, wave length.

In relation to Dr. M. T. Burrows' theory on cancer,¹ I wish to recall two facts. The first is the considerable study and importance attached in Paris by Prof. Roussey's school of Radiation Therapy to the blood reactions and to the state of the cancer-surrounding tissues, especially to the blood vessels. With satisfactory conditions of all these, the treatment is more intensive

¹"Is Cancer a True Disease or Merely the Result of a Condition of Change in the General Organization of the Organism?" by Montrose T. Burrows, M.D., RADIOLoGY, May, 1925, p. 107.

and the prognosis better. The second fact is the recent experimental demonstration of the great influence of blood circulation upon the results of penetrating X-ray treatments. If out of two similar organs or parts of organs in a living body, one is ligated so that the blood circulation is prevented, and if both organs or parts of

organs are submitted at the same time, under the same conditions, to a heavy dose of hard X-rays, the effects of radiation are strikingly different; they are intensive in the organ where plural circulation has been preserved, but not in the others. These experiments are still going on in the Radium Institute in Paris.

Cardiac measurements.—This paper represents a study of twenty cases in which the size of the heart was computed from orthodiagrams after the method of Zwaluwenburg. The formula for computing the area of an ellipse was utilized, namely, the product of the long diameter drawn through the center of the figure and the short diameter erected perpendicularly thereto, at the widest portion, multiplied by the factor 0.7854. That this method is very accurate has recently been shown by Karshner and Kennicott in a study of one hundred cases. They found an average variation of 2.6 per cent between areas determined by planimeter readings and those figured on a basis of the Zwaluwenburg formula.

Cardiac areas, as computed from orthodiagrams, show a fluctuation during compensation and decompensation. In cases of lowered cardiac reserve enlarged hearts are seen to decrease in size with clinical improvement. In a small number of cases subsequent enlargement of cardiac area accompanying clinical improvement and resumption of exercise would point to cardiac hypertrophy.

It is the authors' opinion that correlation of cardiac areas and clinical findings are of value in determining treatment and indicating prognosis.

SOLOMON FINEMAN, M.D.

Area Changes in Hearts Showing Decompensation and Lowered Cardiac Reserve, with a Report of Twenty Cases. Donald J. Frick, Robert H. Kennicott, and Rolla G. Karshner. Calif. and West. Med., Feb., 1925, p. 183.

Experiments on the adrenal.—A preliminary report of experimental work on the effect of radiation on the adrenal. The authors believe that many of the ill effects attributed to

adrenal injury really have some other explanation. Direct heavy radiation of the isolated left adrenal following the removal of the right adrenal of a dog produced no symptoms during practically a month of observation, although a marked fibrosis occurred in the radiated gland. The same dose produced cachexia and death when applied to an isolated loop of small intestine, and marked fibrosis when applied to the upper pole of the kidney.

J. D. CAMP, M.D.

The Effect of Roentgen Rays on the Adrenal Gland. Charles L. Martin, Fred T. Rogers and N. F. Fisher. Am. Jour. Roentgenol. and Rad. Ther., Nov., 1924, p. 466.

Foreign bodies in bronchi and esophagus.—The writer reports his results in forty cases of foreign body removal from the bronchi and esophagus, and considers the X-ray of the greatest help in the diagnosis of foreign bodies. No patient should be operated upon without first having had proper X-ray study. If the foreign body is not opaque, the X-ray will be inclined to show a pathological picture indicating its location. If it is opaque, plates taken in different planes will show its exact shape and relation to the structures. At least one plate should be taken in the plane showing the longest dimension of the foreign body. Non-opaque foreign bodies in the esophagus can often be demonstrated with an opaque meal, either by a filling defect when the esophagus is filled by the meal, or by retention of barium about the margins of the foreign body, outlining it after the rest of the barium has passed on.

SOLOMON FINEMAN, M.D.

Foreign Bodies in the Respiratory and Upper Digestive Tracts. Simon Jesberg. Calif. and West. Med., Jan., 1925, p. 52.

EDITORIAL

M. J. HUBENY, M.D. Editor
EDWARD W. ROWE, M.D. Associate Editors
BENJAMIN H. ORNDOFF, M.D. . . . }

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THE FUTURE OF RADIOLOGY

Immediately following the discovery of the X-ray, when the science of radiology was in its infancy, those who took up this new line of work were looked upon with some degree of contempt. In that day, the problems presented by the new science were more or less physical problems concerning the perfection of apparatus and technic, so as to secure more satisfactory radiographs.

The very nature of the science, at that time, led many individuals without medical training to engage in the work, and caused physicians to look down upon any of their number who embarked upon this field of endeavor, apparently so foreign to medicine. The very attitude of the medical profession toward the workers in this new field compelled them to seek counsel among themselves.

THE SITUATION AS IT WAS IN THE LAST DECADE

The last decade, however, has seen a distinct change in the problems of radiology. The physical problems which heretofore held the important place in the science of radiology, became the problems of minor importance; medical problems, the interpretation of pathological findings in the radiograph, became those of foremost importance. This stage marked the passing of the lay radiologist. It is true that some men, other than physicians, are still engaged in the practice of radiology, but these are relatively few and represent those who went into the work when its character

presented a legitimate field for the layman, and who, having made friends during that time, are still permitted to continue their previous practice. With the continuous advancement of radiology the lay worker will become less and less a factor in the practice of this branch of the science of medicine.

THE SITUATION AS IT IS NOW

With the passing of the lay radiologist, however, all our troubles are not ended. We are confronted by even more serious conditions. Probably one of the most serious of these is the commercial laboratory, usually owned by laymen and operated by an insufficiently trained physician, who accepts a small salary in order to get the benefit of a large experience. The dollar being the foremost consideration, inferior work is ground out in large amounts, unscientific reports are spread far and wide, and, as a result, radiology is discredited among the very physicians whom it should most effectually serve. At times unethical practices are carried on in connection with such laboratories which tend to lower still more the standing of the physician who supports such institutions. Situations are known where a commercial X-ray laboratory, being forbidden by law to operate, has secured the name of a physician under which it operates, when the physician himself has no active connection with the laboratory. That physicians should lend themselves to such prostitution of their profession seems unbelievable, and that medical societies or medical licensing boards do not act to curb such action is equally hard to understand.

The constantly increasing amount of X-ray work done at free clinics with little or no cost, and the flagrant abuse of these clinic rights, is a menace to the legitimate

practice of radiology even more than to the other branches of medicine.

In recent years there has been a growing tendency on the part of hospitals to capitalize their X-ray departments at the expense of the radiologist. Gradually but surely the customary division of gross receipts on the fifty-fifty basis for radiologist and hospital has shifted to forty-sixty, and even thirty-three to sixty-six in favor of the hospital. The continuous demand of medical men in other branches of medicine for lower and lower X-ray rates has caused many hospitals to lower their rates to such an extent that they cannot possibly be met by physicians in private laboratories. Working as tax-free institutions, unmindful of the cost of rent, light, heat, other upkeep, interest on the investment, etc., things which necessarily enter into the expense account of the private laboratory, such hospitals may show at least a paper profit with very low rates. Even when such hospitals draw their clientele solely from the hospital patients, they do, by their example, create an unfavorable opinion of the private laboratory; and where they not only draw patients from the hospital, but accept patients from outside physicians as well, then they enter into ruinous competition with private laboratories. Where hospital X-ray laboratories accept outside cases, similar rates to those prevailing in outside laboratories should be charged.

The exceptional aid of X-ray in diagnosis has induced many medical men to install X-ray equipment of their own and attempt to do their own X-ray work. (The process is presented as simple and the profits as large and easy by the X-ray salesman.) That this is their inherent right no one can gainsay; but that the mere possession of an X-ray machine is not one of the foremost qualifications of a radiologist today, will not be disputed by any who has had even meager experience in radiology. Radiology is a science based on the knowledge of the various disease processes and their translation from the radiograph. This science requires not only a fundamen-

tal knowledge of pathological processes, but also a long experience, with observation of a large amount of material under the guidance of an experienced radiologist. The radiological experience incident to the private practice of a single individual will rarely, if ever, be sufficient to give proper familiarity with radiological work to qualify him as a radiologist. As a result, many false diagnoses will be made by those attempting radiology as a side-issue in their practice, and radiology as a science will suffer.

THE REMEDY

The reason for the patronage by physicians of such commercial cut-rate laboratories is obviously because they are cheap. The physician seeks to obtain information at the lowest cost, not realizing that the same careful work by a well-trained man cannot be turned out in such quantities as are necessary to establish such low rates. A "radiograph is a radiograph," and the interpretation is considered as of so much value, by the physician, no matter by whom given. In other words, the average physician, even one engaged in a specialty, does not fully realize the possibilities of X-ray for diagnosis and treatment, nor does he understand the large factor which experience plays in the development of the radiologist. The same answer applies to those who install X-ray apparatus and, without training, attempt to do their own X-ray work. Such men must necessarily draw from their own practice only for their radiological practice, which (except in very exceptional instances) can never attain sufficient magnitude to render them proficient in X-ray work. They are like the general practitioners who attempt to do their own surgery; they can do the minor things in a more or less mediocre fashion, but never attain proficiency in their surgical endeavors.

It would seem then, to correct this condition, that it would be necessary to educate physicians to the true status of radiological

work. This can best be accomplished by a full and open conference between physician and radiologist in all cases in which they are associated. The radiologist need not fear that by his open discussion of the subject he will divulge some secret of diagnosis which will enable the physician to acquire the same knowledge of radiology which he himself has. If, by word of mouth, a radiologist can impart to the physician or surgeon with whom he works all there is to know about radiology, without the benefit of experience which he has worked years to acquire, then the science of radiology does not deserve the name of "specialty." Each individual radiologist can carry out this program of demonstrating the magnitude of radiology to the medical profession, among his own clientele. This is not sufficient, however, to cope with the future. Radiology is advancing so rapidly and the demand for radiological work is becoming so great, that a large number of young men, many of them inadequately trained, are taking up the work. Before a radiologist can impress the physician or surgeon with the import of his work, he must be well grounded himself in the fundamental principles of radiology and in the physiological and pathological processes which underlie the interpretation of radiographs. The experienced and established radiologist will serve himself and the public better and the science of radiology better, if in every way possible he aids the development of the well-qualified young men who enter the field of radiology. By individual proficiency the science of radiology will be judged.

It is not sufficient for us to give vent to our feelings now and then through some magazine article or in some medical society and then lapse into silence; in order to carry the thing over it will be necessary to make some concerted move by organized radiology. What better organization could be had than that now existing in our State Counselors and Executive Committee? How much more profitable it would be at our annual executive session to have the

Counselor from each state report the membership of various roentgen clubs and societies active in his jurisdiction and what he is doing to carry out a definite program formulated by the Executive Committee or Society as a whole, for the advancement of radiology. Matters of general interest could be brought up as to practices carried on in various hospitals in the district. By such an organization material of vital importance to radiology could be distributed. Such information as (1) the number of medical state boards examining in radiology and the character of their examinations; (2) the number of medical colleges maintaining departments of radiology, and the character and extent of their courses; (3) the number of hospitals maintaining trained radiologists, etc., could be collected and disseminated to the ultimate good of all.

The present time is a critical one in the development of radiology, and, unless properly guided, years of fruitless endeavor may be spent in an effort to absorb radiology into the various medical specialties, which might better be used in the natural advancement of the science.

L. R. SANTE, M.D.

ROENTGENOLOGICAL SECTION OF WISCONSIN STATE MEDICAL SOCIETY

The Roentgenological Section of the Wisconsin State Medical Society prepared the following program for their meeting at Madison on April 30:

Opening remarks of the Chairman,
MANLY J. SANDBORN, M.D.

Report of the Secretary, C. W. GEYER,
M.D.

Discussion of organization and future
plans for the Section.

How members of the Section can have a
special piece of apparatus made, C. R.
BARDEEN, M.D.

Demonstration of the use of X-rays in
teaching physiology, WALTER J. MEEK,
M.D.

Demonstration of the use of X-rays in teaching anatomy, WALTER E. SULLIVAN, M.D.

Special technic in cardiac roentgenology, J. A. EYSTER, M.D.

Special technic in pulmonary roentgenology, W. S. MIDDLETON, M.D.

Special technic in renal roentgenology, B. H. HAGER, M.D.

Special technic in gastro-enterology, J. N. SISK, M.D.

Demonstration of special technic of cranial roentgenology, FRED J. HODGES, R.T.

Common Misconceptions in Radiotherapy, A. U. DESJARDINS, M.D. (Address at dinner held at Madison Club.)

PRACTICAL LECTURES. Delivered under the auspices of the Medical Society of the County of Kings, Brooklyn, New York (1923-1924 Series). Pages, 485; illustrations, 132; color plates, 3. Paul B. Hoeber, Inc., New York, 1925. Price \$5.50.

This is a most commendable volume, containing the practical lectures of a group of distinguished American medical and surgical leaders who addressed the Medical Society of the County of Kings (Brooklyn, New York), during 1923-1924. It opens with a diagnostic discussion by Joseph A. Blake upon the Surgical Abdomen. Other high points are: Harlow Brooks upon the Treatment of Pneumonia, John B. Deaver upon Surgical Diagnosis (particularly with reference to the collaboration of a pathologist), James Ewing upon Rational Pathology and the New Therapeutics, Russell S. Fowler upon the Diagnosis of Abdominal Tumors, Thomas McCrae upon the Chronic Diseases of Joints, Herman O. Mosenthal upon Renal Function in Clinical Medicine, Frederick Tilney upon Epidemic Encephalitis, and James J. Walsh upon Medical Psychology. There are twenty-five recorded lectures in all.

One wonders whether the membership of this county medical society fully appre-

ciates its opportunities of listening to this marvelous array of modern medical masters. Physicians travel far in less populated districts to hear even one or two such distinguished guests. Are Brooklynites so blasé that they demand extraordinary programs to bring them out? More probably an ambitious program committee has taken advantage of the close proximity of these stars and thus sustained the waning interest in purely local programs.

At any rate this series of lectures has resulted in providing Hoeber with rare contents upon which his good printer, Gowdy, displays artistic typographical skill. Familiarity with this excellent volume would give it the distribution it deserves. Kindly observe again the lecture titles in the first paragraph and remember there are fully fifteen more of equal excellence.

ESSAYS AND ADDRESSES ON DIGESTIVE AND NERVOUS DISEASES AND ON ADDISON'S ANÆMIA AND ASTHMA. By Arthur F. Hurst, M.A., M.D., Oxon., F.R.C.P., Physician, Neurologist and Director of Advanced Studies, Guy's Hospital. Paul B. Hoeber, Inc., 1925. New York. Price \$6.00.

Possibly no English internist has been of greater value to the development and encouragement of medical radiology than Hurst. One realizes the range of his activities when noting his positions as Physician, Neurologist and Director of Advanced Studies at Guy's Hospital. He first attracted the attention of radiologists and internists when he published his experiments upon the *Sensibility of the Intestinal Canal*, and, second, by his *Constipation and Allied Intestinal Disorders*, which has already enjoyed a revised edition.

Hurst is a typical English essayist—good choice of words, not too didactic or dogmatic, with a dry wisdom that employs wit. One can easily imagine that he has an engaging personality and that he is a scientific and popular success as a physi-

cian. Let us look him up at the Radiological Conference at London in July!

In this volume Hurst attracts radiologic attention in essays on: The Hypersthenic Gastric Diathesis; Achlorhydria and Its Relation to Other Diseases; Achalasia of the Cardia (so-called Idiopathic Dilatation of the Esophagus, or Cardiospasm); Pelvic-rectal and Anal Achalasia (Hirschsprung's Disease; so-called Congenital Idiopathic Dilatation of the Colon); The Sins and Sorrows of the Colon; Ulcerative Colitis; Chronic Appendicitis and Appendicular Dyspepsia.

His essays, as above, are worthy of our careful reading. They put the thoughts of a practical clinician around the X-ray shadows. The introduction of the term "Achalasia" (not relaxing) of the cardia to our time-accepted "cardiospasm" is most agreeable, likewise "Anal Achalasia," corresponding to our Hirschsprung's dilatation of the colon above a non-organic but tight anus or sigmoid. It is easy, too, to recommend a reading of the essays upon "The Hypersthenic Gastric Diathesis." This affords clinical vision in those cases which seem to have peptic ulcers and yet of which we are not positive, radiologically, i.e., all the secondary signs are present but we fail to record an undeniable filling defect. The essay upon "Chronic Appendicitis" adds several good points to our American conception of appendiceal radiology, in that Hurst combines an air-inflation of the colon to elicit Bastedo's sign and thereby identify this sign more exactly.

There are other essays upon Tetanus, Asthma, Addison's Disease, etc., which are only mentioned to indicate Hurst's breadth of clinical interest. There surely is no doubt in your radiologic mind but that the more we know of clinical values, the better we can interpret shadow-values. If you know all about the radiology of constipation, you don't need to read Hurst's essays. Otherwise, you do!

If you are willing to accept some help in affording better radiologic values to

your clientele in that grand array of constipated patients with *beaucoup* symptomatology and *pas de tout* pathology, then look this book up, not forgetting Hurst's companion volume upon *Constipation and Allied Intestinal Disorders*.

DISEASES OF THE HEART. By Dr. Henri Vaquez, Professor of the Faculty of Medicine of Paris. Translated and edited by George F. Laidlaw, M.D., Associate Physician to the Fifth Avenue Hospital, New York City. Introduction by William S. Thayer, M.D., Johns Hopkins Hospital, Baltimore, Md. Octavo volume of 743 pages. Illustrated. W. B. Saunders Company, Philadelphia and London. 1924. Cloth. Price \$8.50 net.

Radiologists are familiar with the original X-ray cardiac investigations of Dr. E. Bordet, who is associated with Professor Vaquez. Bordet's cardiac index upon two meter X-ray plates is becoming of increasing value to internists and cardiologists. Vaquez and Bordet have published a volume upon cardiography which has enjoyed an English translation. This new book by Vaquez carries a chapter which thoroughly exposes, in a more condensed manner, the studies of Bordet. An increasing distribution of the known values of this simple cardiac X-ray examination is desirable.

Professor Vaquez would not permit his book to go into the hands of his American confrères without careful revision. Several chapters have been re-written, and the whole brought up to date. It is an authoritative and helpful book, the last word of the foremost cardiologist of France.

The comprehensive historical survey given in the Introduction by Dr. Thayer is especially valuable. The arrangement of material is noteworthy; no elaborate system of numbers and footnotes, of freak paragraphing or marginal italics mar the reading material. The bibliographic references found at the end of the main chapters are complete summaries of the subject under discussion.

The book has five main divisions. Part One covers cardiae anatomy and physiology and methods of examinations—objective, subjective, radioscopic, mechanico-graphic, electrocardiographic and sphygmomanometric.

Part Two contains nearly three hundred pages devoted to the cardiopathies and arterial hypertension. Part Three takes up the erythemas. Part Four gives the test for functional efficiency and an exhaustive account of heart failure; causes, major syndromes, hypertrophy and dilatation of the heart, and the pulmonary, hepatic and renal complications of heart failure. Part Five outlines treatment by diet, physical and medicinal agents, and instruction in adaptation of the patient with a heart lesion.

Professor Vaquez contests strongly the attitude of Lewis and MacKenzie, who would reduce all cardiac pathological problems to an estimation of the functional efficiency, by use of the newest mechanical methods, thus ignoring the differential diagnosis of heart murmurs heard above the heart. MacKenzie attaches no importance to mitral insufficiency, it being impossible to prove that normally the valve does not permit some reflux of blood. While admitting that a valvular lesion is not a disease until it produces symptoms, yet Professor Vaquez will not allow us to ignore a condition that may expose a pregnant or post-partum patient to grave dangers, nor permit an unwarned patient errors in over-fatigue or diet, that might result in heart failure.

He endorses electrocardiography, deplored the general practitioner's lack of this diagnostic measure; yet he states that in the diagnosis of valvular lesions the *radiological examination* is preferable. All laboratory methods are a means only and not the end of solving cardiac problems. Professor Vaquez urges that the individual patient be studied at the bedside. To quote him in his preface to the American edition, "Initiated early by my master, Patain, in the problems presented by dis-

eases of the heart, I have never ceased to study them. With age, having acquired some experience, I trust it is not indiscreet to share with my contemporaries the lessons learned by long and patient observation."

EDWARD H. SKINNER, M.D.

SURGERY OF THE SPINE AND EXTREMITIES.
A Textbook for Students and Practitioners. By R. Tunstall Taylor, B.A., M.D., F.A.C.S., Professor Orthopedic Surgery, University of Maryland, Baltimore, Md. Pages, 550; illustrations, 604. P. Blakiston's Son and Company, Philadelphia.

This is truly a complete and comprehensive text-book on orthopedic surgery. The author has not only given to us his own experiences and methods, but has also collected much valuable data and many operative procedures from the leading orthopedic surgeons of the country. His historical notes in the preface are most interesting and instructive.

The book is divided into three parts: First, Orthopedic Technic. This chapter deals with the technic of plaster dressings, extension and traction apparatus, various fracture frames, splints, supports, and the application and care of braces. Then tenoplasties and bone grafting are taken up at length and an excellent chapter on surgical mensuration and diagnosis completes Part One. The second part deals with the spinal affections, such as tuberculous lesions of the spine, non-tuberculous lesions of the spine, with an elaborate chapter on the etiology and correction of lateral curvature. The third part is given to affections of the extremities.

The subject matter is well handled and the arrangement is very good. The text is profusely illustrated with halftones and drawings. This is a book which should be on the desk of every student for study and on the shelf of every practitioner for reference.

REX L. DIVELEY, M.D.

ABSTRACTS OF CURRENT LITERATURE

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Colon examination.—The clinical evidence in most cases of colonic disease is meager, variable, and often unreliable. The sigmoidoscopic examination covers only the last few inches of the colon itself. In colonic disease the opaque enema is as valuable as the opaque meal in the diagnosis of gastric lesions.

The writer finds the use of a Higginson syringe of considerable value during the injection. With it the flow can be hastened and, what is still more important, any alteration in the colonic tension is at once conveyed to the hand. With experience one becomes very sensitive to any alteration or variation of this colonic tension, so much so that it becomes possible to distinguish between the increased tension caused by muscular contraction, such as peristalsis or spasm, and that of obstruction by a newgrowth. In some cases it is difficult to examine carefully the overlapping loops of the pelvic colon. The author overcomes this difficulty by injecting a few ounces of warm water. This dilutes the contents of the lower bowel, rendering the shadows less dense, and one coil can in this way be seen through the other.

A considerable variation in tone occurs in the colon, similar to that seen in the rest of the gastro-intestinal tract. This is determined to a great extent by the mental attitude of the patient. A tendency to hypertonicity occurs more frequently in the descending colon. If it is a purely spastic condition the contracted

lumen will relax before the end of the examination. In cases of spastic constipation, no relaxation may take place during the entire period of examination.

In discussing obstruction resulting from the presence of a newgrowth in the colon, the writer has noted that the passage of an opaque meal given by mouth may be quite unobstructed and yet the obstruction may be complete to the barium enema. His explanation of this phenomenon is that the channel through the newgrowth is moulded—probably into the shape of a funnel—by the onward passage of feces, a valve-like closure taking place when the enema is administered. He further states that it is rare for a colonic growth to be present without giving rise to definite obstruction to the passage of the opaque enema.¹

Tuberculous disease of the colon closely resembles a newgrowth in its radiologic appearance. Tuberculous disease causes a narrowing and distortion of the gut, but this is usually limited to one side, not involving, as with a newgrowth, the entire lumen.

In England, at least, the barium enema is not resorted to sufficiently often as a diagnostic measure in colonic disease. While, if careful attention is given to technical details, the method is both rapid and accurate and of minimum discomfort to the patient, it must also be realized that the examination is beset with pitfalls for the unwary.

SOLOMON FINEMAN, M.D.

Radiological Examination in Organic Diseases of the Colon. The Opaque Enema Method. S. Gilbert Scott. *Brit. Med. Jour.*, Jan. 24, 1925, p. 151.

Gall-bladder tests.—The observations reported are based on 178 patients examined by the Graham method; of these, 39 were operated upon. In the absence of both surgical and pathological proofs, little definite information can be derived from the cases not submitted to operation. However, less than one-fourth of them responded normally to the test.

The gall bladder failed to fill with the dye in nineteen of the twenty-five cases with gallstones. Shadows of the gallstones themselves were visible in six cases, either in the preliminary roentgenogram or after the dye was given. Dye entered the gall bladder in six cases but in two of these the shadow was mottled with transparencies; in one, the dense shadow of stones was seen within that of the gall bladder, and

in one the gall bladder was faintly visible at the eighth hour only. In only two cases could the findings be construed as negative.

There were fourteen cases in which there was a definite lesion of the gall bladder but no stones. In eight the gall bladder failed to fill with the dye. Abnormalities of filling were noted in three cases; the gall bladder was depicted only at the twenty-fourth hour in one of these, and in the other two was shown at the fifth and eighth hours only. No abnormalities of filling were observed in the remaining three cases. Of the total 39 patients examined and followed to operation, 34 gave definitely abnormal responses to the Graham test.

Owing to the resulting reaction, the employment of the dye is inadvisable when obstruction of the common duct is known to exist. In some cases of cholecytic disease in which there was no obstruction of the hepatic or common duct, reactions ranging from mild to severe were experienced. The typical reaction is one of vasomotor shock. Owing to the possibility of a reaction, the method is unsuitable for patients with any type of cardiovascular disease, particularly arteriosclerosis and chronic cardiac disease.

Because of the numerous reactions experienced the standard dose of 5.5 gm. was reduced to 4.5 gm., and more satisfactory results were obtained. As the reactions simulate vasomotor depression the authors give hypodermically 10 minimis of a 1:1,000 solution of adrenalin chlorid just as the blood pressure begins to rise after the initial drop. This checks the nausea and vomiting and restores the blood pressure to normal.

Technic.—1. The patient is hospitalized during the first twenty-four hours. No special preliminary preparation is required, but neither fluid nor food is taken after 5 A.M. of the day of the examination, nor are enemas or cathartics taken. 2. Four and one-half grams of the salt is added to 40 c.c. of triple distilled water, heated slowly and stirred gently until it dissolves, which readily occurs. The mixture is then sterilized in a boiling water bath for fifteen minutes and cooled to body temperature for use. 3. The dye is administered intravenously in two equal portions, one-half hour apart. If the dose is divided the second portion is better tolerated. The median basilic vein is selected whenever possible. If the cephalic vein is used, thrombosis may occur. Extreme care should be taken that none of the solution gets outside of the vein, for it is very irritating. The injection is made slowly, consuming from five to seven minutes. Rapid administration is likely to produce toxic symptoms and severe pain along the vein. Heat relieves this pain.

¹The abstractor has seen a number of cases of carcinoma of the colon in which there was practically no obstruction to the flow of the opaque fluid. In these cases, however, there were persistent filling defects in the contour of the colon.

4. Roentgenograms are made at the fifth, eighth and twenty-fourth hours after giving the dye. Roentgenograms should always be made prior to giving the dye. When they yield positive findings the dye-test is unnecessary. 5. The stomach and duodenum are kept as nearly empty as possible by giving only a glass of milk or a cup of tea at noon, a small amount of water in the afternoon and a non-protein dinner in the evening. The next morning the patient may resume his normal diet and be dismissed from the hospital.

Normally the gall bladder will retain sufficient dye to cast a shadow at the fourth or fifth hour after administration. This shadow attains its greatest intensity some time between the eighth and twenty-fourth hours, becomes progressively thinner thereafter, and should disappear between the twenty-fourth and forty-eighth hours. The shadow is larger at earlier than at succeeding hours. This variation in size is important evidence of normal distensibility and contractility.

Abnormal responses include failure of the gall bladder to fill with the dye, scanty filling as shown by persistent faintness of the shadow, delayed filling, marked delay of emptying, deformity of contour, unvarying size of the shadow, constant extremes of size and mottling or central defects. In the absence of cirrhosis or gross impairment of hepatic function interference with filling suggests obstruction, due to gallstones, adhesions, newgrowths, thickened bile, or other pathologic conditions. Unvarying size of the shadow implies loss of elasticity of the gall-bladder walls. Mottling of the shadow suggests stones or papillomas.

J. D. CAM, M.D.

Roentgenologic Diagnosis of Cholelithic Disease with the Aid of the Sodium Salt of Tetrabromphenolphthalein. Russell D. Carman and V. S. Counseller. *Am. Jour. Roentgenol. and Rad. Ther.*, Nov., 1924, p. 403.

Sphincters of the alimentary canal.—The work of Bayliss and Starling showed that peristalsis consists of a co-ordinated reflex in which a wave of contraction, preceded by a wave of relaxation, passes down a hollow viscus. When considered in relation to the action of sphincters, it means that a sphincter should relax at the approach of each peristaltic wave.

The author is of the opinion that a cardiac sphincter exists, and that it is located at the esophageo-gastric junction. Although in adults there is no obvious thickening of the circular muscle coat at the cardia, the existence of a specialized cardiac sphincter is made fairly certain by Keith's demonstration of a nodal tissue plexus similar to that of the auriculo-

ventricular bundle of the heart, located in the very distal portion of the esophagus. Further evidence of the existence of such a bundle can be seen fluoroscopically. When food reaches the end of the esophagus its progress is momentarily arrested, owing to the resistance of the sphincter. Immediately afterwards the sphincter relaxes, but even then the lumen of the sphincter is very much less than the rest of the esophagus.

In cardiospasm, in which one may find an enormously dilated esophagus, with a greatly hypertrophied muscular coat, no one, however, has ever discovered after death an obstruction at the cardia. A careful examination of many specimens has shown that the last inch of the esophagus, the site of the cardiac sphincter, is never dilated nor hypertrophied. The writer believes, therefore, that the term "cardiospasm" is a misnomer, particularly so, because even during life the passage of a bougie through the esophagus offers no resistance when the cardia is reached and can be withdrawn without the slightest drag, such as one would feel if the grip caused by spasm were present. The writer concurs in the opinion expressed by Rolleston in 1895, that in these cases the dilatation of the esophagus is due not to spasm but to the obstruction resulting from failure of the co-ordinating mechanism to relax the cardiac sphincter during the act of swallowing. He believes the condition may result from degenerative diseases involving the nodal tissue of the sphincter or from gastric and other abdominal disorders causing inhibition of relaxation of the cardia. He treats his patients by the passage of a large mercury tube, which they soon learn to pass themselves, with marked or total relief. He does not favor the forcible dilatation of the cardia with Plummer's hydrostatic apparatus, because of the pain and inherent danger of a fatal peritonitis.

PYLORIC SPHINCTER

Until recently Cannon's theory of the "acid control" of the pylorus was universally accepted. The recent work, however, of Carlson and Litt on anesthetized animals, and of Baird, Campbell, and Hern on healthy men has shown that other factors also play an important rôle in controlling the activity of the pylorus. The pyloric canal opens under normal conditions on the approach of every peristaltic wave, from the very beginning of digestion, before free acid has appeared in the stomach, until the last trace of chyme has been evacuated, whether this is very acid, as in hyperchlorhydria, or actually alkaline, as in achylia gastrica. The presence of an ulcer in the duodenum frequently upsets the normal pyloric mechanism by giving rise to

a protective reflex, namely, an inhibition of pyloric sphincter relaxation, which in turn results in delay of evacuation of the gastric contents and a subsequent dilatation of the stomach. This condition has often been regarded as the result of pylorospasm. Pyloric spasm is present in all probability then only when it is demonstrable by fluoroscopic examination that nothing can be pressed through the pyloric channel. X-ray examinations have proved that the hunger pains of duodenal ulcer occur when the stomach is nearly empty and disappear when evacuation is nearly complete. This corresponds with the only time that peristalsis can increase the pressure within the pyloric vestibule, as each wave then separates the contents of the small part of the stomach distal to it almost completely from the contents of the large part proximal to it. If the pyloric sphincter does not relax, owing to the irritation of the ulcer by the very acid gastric contents two or three hours after a meal, the pressure within the pyloric vestibule can spend itself only to a slight extent dynamically by producing an exceptionally active axial reflux stream. Consequently the tension on the muscular coat of the pyloric vestibule is greatly increased. This is the actual cause of pain, namely, the rise in tension of the individual muscle fibers, resulting in an afferent nervous impulse, which calls

forth the sensation of pain as well as the associated reflex symptoms of tenderness and rigidity in the corresponding segment of the rectus abdominis muscle.

The author's investigations proved that the mucous membrane of the alimentary canal is insensitive to tactile, thermal, and painful stimuli; that neither the normal mucous membrane nor the surface of an ulcer is sensitive to hydrochloric acid of a strength greater than is ever present in the stomach, either in health or disease, and that tension in the muscular coat is the sole cause of the sense of fullness, and, when it is sufficiently intense, of the sense of pain. When a gastric ulcer or disease of the gall bladder causes a failure of pyloric relaxation the pain produced is identical in character with that of duodenal ulcer.

Hirschsprung's disease and the milder form of the disease occurring in adults are not associated with organic obstruction. The writer believes that here, too, the obstruction is due to a loss of power of relaxation of the pelvi-rectal or anal sphincters. The condition is exactly comparable to the dilatation and hypertrophy of the esophagus in so-called "cardiospasm."

SOLOMON FINEMAN, M.D.

The Sphincters of the Alimentary Canal and Their Clinical Significance. Arthur F. Hurst. *Brit. Med. Jour.*, Jan. 24, 1925, p. 145.

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